INTERNATIONAL JOURNAL OF
SCIENCE ARTS AND COMMERCE

The changes in aquatic plant cover in the selected tanks effect from The Renovation of small Tanks in Dry Zone in Sri Lanka (Case Study In Galgamuwa Division in Kurunegala)

K.P.L Nishantha

Department of Geography & Environmental management, Faculty of Social Sciences and languages, Sabaragamuwa University of Sri Lanka, Belihuloya.

Abstract

Key words : Small tanks, Dry zone ,Renovation, Aquatic eco system, Aquatic plants in antiquity, multi-purpose institutes and organizations had involved in small tanks renovation in tanks renovation in- whereas at present, Department of Agrarian Development, Irrigation Department, Samurdi Authority, Gamanaguma Project and NGO-s engage in this pursuit. They applied removing soil from tank, renovating tank bund, removing plant cover on the tank, slues repairing, wana (spill) repairing and channel repairing as types of tank renovation.This research focused on identifying the changes of the aquatic plant species living in the tank environment after small tanks Renovation. Small tanks in Sri Lanka are those with an irrigated command area of 80 ha (1 ha = 2.47 acres) or less. The study was conducted with regard to 12 small tanks in Galgamuwa DS division in Kurunegala district where 77 no's of renovated tanks during the last 15 years are located. Questioner survey, Selected PRA tools and Field Plot Transects were used for data collection and data were statistically analyzed in disclosing the following findings. Distribution of blue water Lilly, Kekatiya, Water hyacinth and Diyameneri are significantly decreased. The invasive alien invasive plants grown in the tank and the surroundings have been a major threat for the existence of the marshland environment and related hydro systems. Many problems have been created by the distribution of invasive aquatic plants especially in the small tanks. The population and distribution of Lilly, Blue water lilly, Plant of hawai, Buduraspasi, Salvenia and Water spinach after the tank renovation negative significantly changed. Lotus plant that was one of the mostly grown plant species before the renovation has become the sixth abundant plant with renovation. Salvieniya has also decreased to the sixth place. Kekatiya and Water hyacinth can be largely seen even after the renovation as they can grow faster. The removal of aquatic plants, specially the

invasive plants from the renovated tanks has positively influenced the ecosystem of the tanks. Further, the removals of the plants beneficially influence some aquatic faunal species. Further, the removal of these plants has prevented addition of aquatic organic matter into the tanks and this has beneficially influenced maintaining the dissolved oxygen level in the tank system. Therefore, the reduction in aquatic plants has more beneficial impacts to the tank system.

Introduction

There are a number of small tanks in the north part of the Kurunagala district, which preserve the water requirement of people. In Galgamuwa Divisional Secretariat (DS) division, this minor irrigation system is providing not only the water needs, but it also conserves the environmental quality of the whole area of the dry zone. Therefore, it is a man-made Eco- friendly ecosystem which is not taken care of effectively in recent times. Yet, the studies are being carried on to discover whether this can be developed as a solution for the water scarcity of the dry zone area.

Further, this study scrutinizes the changes of the bird species taken place in the tank environment after the renovation process by comparing it with the past situation. The finding can be used in other development programs of small tanks that concern about their eco-friendly environment which helps to improve the village ecology and economy. Moreover, this experience can be too applied in other development programs such as reservoirs. Thus, it is distinct that this problem is truly significant to be studied.

Small tanks are used for collecting runoff water during the monsoon for irrigation and domestic water supply. They are created by constructing an earthen bund across a natural drainage basin. According to Aheeyer (2005),Ausadahami (1999), Darmasena (1991, 1995), MaddumaBandara (1980,1985)&Thennakoon (2002, 2004) tanks are developed in response to the need for more intensive cultivation when traditional forms of extensive cultivation can no longer support the growing population. Small tanks in Sri Lanka are those having an irrigated command area of 80 ha (1 ha = 2.47 acres) or less.

General Objective

To identify the changes of aquatic plant species living in the tank environment with regard to the renovation of small-scale tanks

Methodology

Study area

The selected site is located in Kurunegala District in the North West Province in Sri Lanka covering an area of 278km^2. The area is representative of a wider agro ecological region known as the Lowland Dry Zone, which experiences high levels of rural poverty associated with short rain fed growing seasons and degrading, nutrient-poor red soils. North West Province is the Province in Sri Lanka most richly endowed with small-scale tank systems which are situated between $7^0 50^1$

north latitude and $8^{0}15^{1}$ and 79 $^{0}57^{1}$to $80^{0}45^{1}$ East longitude. Also the area is located from 300m above sea level.

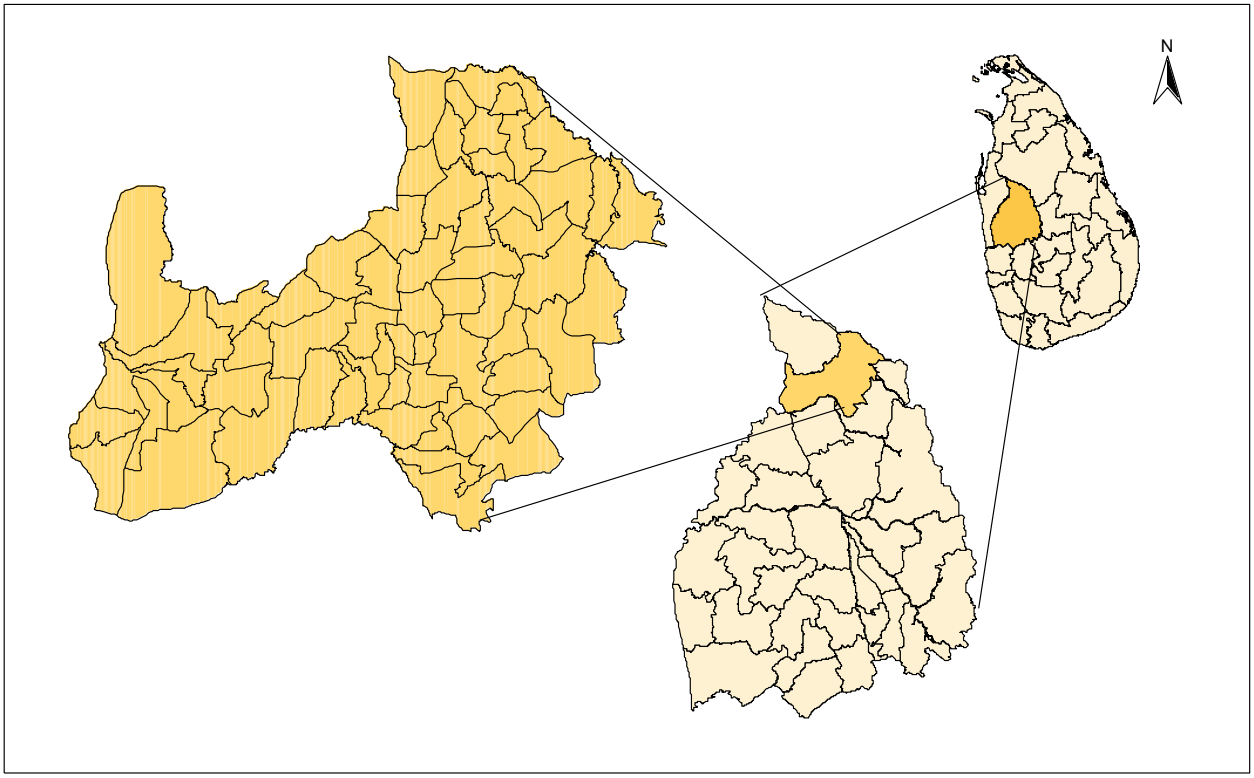

Figure 1 - Location of the study area and Gramaniladhari divisions (GN) of selected tanks
Source-: Land-use planning unit- Kurunegala.
The Division has 182 nos. of small villages and 62 nos. of Gramaniladhari Divisions with the number of service Institutes such as Police Stations, Banks, Schools, Hospitals, etc;

Methods used for Data collection

The study has used primary and secondary data to collect information. Primary data refer to the data which researcher collects individually with his own survey. There are several techniques to collect primary data.

- Questionnaire Method
- PRA
- Focus Group Discussion
- Interviewing
- Observing
- Field plot transects

Secondary data refer to the data which were directly taken from Government or non-government publications. They are also several types.

- Government Publications

- Institutional Publications
- News Magazines
- Journals
- Internet

The primary data for this research were collected by the questionnaire method. Each questionnaire was filled by the researcher while he was discussing with the people in 12 small tank villages, selected using stratified random sampling techniques (table 1, 2, and 3).Further Focus group discussion was included in the primary data. The researcher had discussions with a group of people while supervising the tank environment and those facts are also incorporated in this research paper. Next primary data methods were field observation and field plot transects, the researcher gained an idea about the exact field by observing them.

Selection method for Tank samples (Step I)

Table 1

No of farmers Command area (Akers)	0 - 59	60 - 119	120 - 189	190 - 249	Total
0 – 35	55	3	1	0	59
36 – 71	10	3	0	0	13
72 – 107	0	3	0	1	04
108 – 143	0	1	0	0	01
Total	65	10	01	01	77

Table 2 **Selection method for Tank samples (Step II)**

No of farmers Command area (Akers)	0 - 59	60 - 119	120 - 189	190 - 249	Total
0 – 35	55/77 ×12 = 8	0	0	0	08
36 – 71	10/77× 12 = 2	3/77 × 12 = 1	0	0	03
72 – 107	0	3/77 × 12 = 1	0	0	01
108 – 143	0	0	0	0	00

Total	10	02	00	00	12

Table 3 **Name of selected tanks using random table and no of selected farmers for sample**

In no	Random No	Name of The Tank	No of Farmers	Command area (Akers)	no of selected farmers for sample
01	118	PahalaPulachchiyawewa	58	08	15
02	87	Ihalagamawewa	13	08	3
03	41	Pahalakoonwewa	31	34	8
04	05	IhalaPalukendawawewa	40	12	10
05	11	Ottukulamawewa	18	18	5
06	83	Dullawawewa	49	30	13
07	16	Kurundankulamawewa	35	35	9
08	10	Monnankulamawewa	46	27	12
09	02	PahalaPalukendawawewa	35	35	9
10	29	Bulnewawewa	59	54	16
11	90	Medawachchiyawewa	105	71	27
12	93	Mahagalkadawalawewa	90	75	23
		Total	579		150

Secondary data

It was done using Government reports, periodicals and other publications which have been published by Government or any other institution. The divisional secretariat office, Galgamuwa was also vital in providing data for the research. And also the agrarian office and other sub institutions relevant to farmers' affaires provided secondary data necessary for the research.

Results and Discussion

The Changes of aquatic plant cover in the selected tanks

Aquatic plant cover prevailing on much of the area of the small tanks is a common feature of the small tanks in Sri Lanka. The nature of the aquatic plant cover on the sample tanks from the study area can be understood from Table 5. One feature of the tank renovation is the removal of the aquatic plant cover. Various actions have been taken by the relevant organizations to eliminate the aquatic plant cover. There are good and bad effects of aquatic plant cover on tanks. The most adverse features are limiting the amount of water retained in the tank, removed of water due to evapotranspiration. One of the positive impacts is increment of the humidity and cooling of the surrounding environment.

Questionnaire survey analysis and PRA analysis of aquatic plants

The plant species that can be identified in these tanks are shown in Table 5. Only the plants, which are well known to the tank villagers, were used in this study. The aquatic plants such as Salvenia, Water hyacinth and Lotus invaded most of the small tanks. Lotus grows in a tank when the standing water level is shallow. When Lotus is abundant in a tank, the villagers are in the view of renovating the tank strictly by removing the aquatic plant cover. As an example, the primary renovation need of the villagers of RT 10 tank and RT 6 tank was to remove the aquatic plant cover.

Table 4 Aquatic plant cover in the selected small tanks

Name of the tank	Area of the tank(ha)	Vegetation cover in 2007 (percentage)
RT 1	5.29	80
RT 2	7.05	90
RT 3	14.10	70
RT 4	5.29	80
RT 5	11.45	85
RT 6	10.57	70
RT 7	13.22	75
RT 8	14.10	80
RT 9	11.89	85
RT 10	20.26	75
RT 11	29.07	50
RT 12	26.43	50

Source -: Field observation 2007

Table 5 Identified aquatic plant species by the villages in the selected small tanks

Local Name (Sinhala)	English Name	Species Name
Kekatiya		*Aponogeton crispus*
Gonaparadala		*Elodea canadensis*
Japan Jabara	Water hyacinth	*Eichhornia crassipes*
Hydrilla	Hydrilla	*Hydrilla verticilata*
Nelum	Lotus	*Nelumbonucifera*
Olu	Lilly	*Nemphaea pubescens*
Nil manel	Blue water Lilly	*Nymphoides indica*
Salviniya	Salviniya	*Salvinia molesta*
Kankun	Water Spinach	*Ipomoca aguatica*
Welalakola	Plant of Hawaii	*Colocasia sp.*
Katuhibula		*Salmalia insignis*
Diyameneri		*Musa sapientum*

Keekiridiya		*Eclipta prostrate*

From the above plant species Lotus, Lilly, Blue water lilly, Water hyacinth and Plant of hawaii are available in all the study tanks. As per the Mann-Whitney test done under a 5 percent significance level with the use of statistical methods, the changes in the plant species are observed after the tank renovation. This shows that the tank renovation has affected the growth and distribution of many aquatic plant species grown in the tanks (Table 6). Accordingly, it is confirmed that with the tank renovation, distribution of plant varieties is controlled. The reason is the growth of the aquatic plant cover to the same extent that had at the time of renovation, although the aquatic plant cover was removed to some extent by the dredging of the tank during the renovation process. The aquatic plant cover re-established within a period of two to three years. Siltation with chemical fertilizers that are used by the farmers in the command area has increased the growth capacity of the aquatic plants within a limited time period and non-removal of aquatic plant cover continuously from the tank are the major reasons that created the above situation.

Distribution of blue water Lilly, Kekatiya, Water hyacinth and Diyameneri are significantly decreased at 5 percent significance level after the tank renovation process. The invasive alien invasive plants grown in the tank and the surroundings have been a major threat for the existence of the marshland environment and related hydro systems. Many problems have been created by the distribution of invasive aquatic plants especially in the small tanks. Low level of water remained in the tank is a severe problem to have water for the cultivation. Sunlight does not fall to the interiors of the tank with the growing of invasive plants. Hence, the fish resource in the tanks is subjected to threats. In addition, the flow of water is disturbed by the growth of those plants in water channels which supply water to paddy fields.

High percentage of small tanks in the dry zone belongs to cascade systems (Madduma Bandara, 1985; Panabokke, 1996, 1999, 2000; Tennakoon, 2000 & 2002). Drainage water from one command area or paddy fields flow in to a tank in a low level as a return flow. As the chemical fertilizers used in cultivations are mixed with the drainage water, the tank water gets nutrients. This influences the rapid growth of aquatic plants. All the tanks considered in this research have faced this threat except RT 11 tank that has a deep water level and proper maintenance. Lotus is abundant in the tanks RT 2, RT 4, RT 5 and RT 9. The heavy siltation of these tanks is considered as one of the major causes for this. The growth of Lotus is low in the tanks with high depth of water. In addition, the dredging in the renovation process does not happen in the whole tank bed area. Although the aquatic plant cover is removed to some extent by the renovation process, the aquatic plant cover has grown again within a short period as no proper maintenance is done in the tank after the tank renovation. RT 12 has achieved some success in controlling the aquatic plants by implementing biological methods like introducing biological agents such as insects that feed on the vegetation.

The population and distribution of Lilly, Blue water lilly, Plant of hawai, Buduraspasi, Salvenia and Water spinach before and after the tank renovation is given in Table 6. There is a negative significant change has happened in the growth and distribution of many plants in tank surface.

Table 6 Evaluation of changes of aquatic plant cover in small tanks before and after renovation

Plant species	Steps of renovation	Villagers' Response (percentage)				Significant change in population*
		1	2	3	4	
Lilly	Before renovation	0	6	89	5	Yes(N)
	After renovation	0	83	16	1	
Lotus	Before renovation	1	8	83	8	Yes (N)
	After renovation	0	78	22	0	
Blue water lilly	Before renovation	1	5	74	20	No
	After renovation	0	21	76	3	
Kekatiya	Before renovation	0	1	69	30	No
	After renovation	0	10	64	26	
Keekiridiya	Before renovation	0	81	19	0	No
	After renovation	1	85	11	3	
Plant of Hawaii	Before renovation	0	25	65	10	Yes (N)
	After renovation	0	51	49	0	
Katukibula	Before renovation	0	85	15	0	No
	After renovation	0	93	7	0	
Hydrilla	Before renovation	31	68	1	0	Yes (N)
	After renovation	89	11	0	0	
Green cabomba	Before renovation	37	61	2	0	Yes (N)
	After renovation	88	12	0	0	
Water Hyacinth	Before renovation	1	31	67	1	No
	After renovation	22	49	29	0	
Salvinia	Before renovation	0	35	64	1	Yes(N)
	After renovation	25	72	3	0	
Diyameneri	Before renovation	0	98	2	0	No
	After renovation	1	98	1	0	
Water Spinach	Before renovation	37	61	2	0	Yes (N)
	After renovation	88	12	0	0	

Source -: Field data 2008

1 Not present 2 (1-2 plants per square meter) 3 (3-4 plants per square meter)
4 (More than 4 plants per square meter)

Yes(N) = Negative change Yes(P) = Positive change * 5 percent significance level

Table 7 shows ranking matrix of PRA tool which presents the aquatic plant cover on the small tanks before and after the renovation of the selected small tanks. Kekatiya, Salvinia, Water hyacinth, Lilly and lotus are the most common plants in the tanks. Diyameneri, Hydrilla, and Buduraspasi have shown the least distribution. Lotus grows much in the shallow areas with low water level and its abundance confirms siltation or low depth of the tank.

Table 7 Evaluation of abundance of aquatic plant cover in the tanks before and after tank renovation in small tanks using ranking matrix PRA tool and t test

Aquatic plant species → / ↓ Tank Name		Lilly	Lotus	Blue water lilly	Kekatiya	Keekiridiya	Plant of Hawaii.	Katukibula	Hydrilla	Green cabomba	Water Hyacinth	Salvinia	Diyameneri	Water Spinach	Total marks	Rank for tanks	P value	Significant change at95 percent
RT 1	B	4	4	3	4	4	3	3	3	3	4	4	3	3	45	4	0.00	YN
	A	3	3	3	4	3	3	2	2	2	3	3	2	3	36	7	0	
RT 2	B	3	3	3	4	3	4	3	3	3	4	4	3	3	43	7	0.00	YN
	A	3	3	3	4	3	3	2	2	3	4	3	2	2	37	4	8	
RT 3	B	4	4	3	4	4	4	3	3	3	4	4	3	3	46	2	0.00	YN
	A	3	3	3	4	3	3	2	2	2	3	3	3	3	37	5	0	
RT 4	B	4	4	3	4	3	4	3	3	3	3	4	3	3	44	6	0.02	YN
	A	3	3	3	4	3	3	2	2	2	4	3	3	3	38	2	7	
RT 5	B	4	4	3	4	4	4	4	3	3	4	4	3	3	47	1	0.00	YN
	A	3	3	3	4	3	3	3	2	2	4	3	3	3	39	1	1	
RT 6	B	4	4	3	4	3	3	3	3	3	3	3	3	3	42	9	0.02	YN
	A	3	2	3	4	3	3	3	2	2	3	3	3	2	36	8	7	
RT 7	B	3	3	3	4	3	3	3	3	3	4	4	3	3	42	10	0.00	YN
	A	3	3	2	4	3	3	2	2	2	3	3	3	2	35	9	3	
RT 8	B	4	4	3	4	4	4	3	3	3	4	4	3	3	46	3	0.00	YN
	A	3	3	3	4	3	3	3	3	2	3	2	3	3	38	3	5	
RT 9	B	4	4	3	4	3	4	3	3	3	4	4	3	3	44	5	0.00	YN
	A	3	2	3	4	3	3	2	2	2	4	3	3	3	37	6	5	
RT 10	B	4	4	3	4	4	3	3	3	3	4	4	2	3	43	8	0.00	YN
	A	3	3	3	3	2	3	2	2	3	3	3	3	2	35	10	6	
RT 11	B	3	3	3	4	3	3	3	2	3	3	3	2	3	38	11	0.01	YN
	A	3	2	3	3	2	2	2	2	2	3	2	3	2	31	11	2	

RT 12	B	3	3	3	4	3	3	3	2	2	3	3	2	3	37	12	0.008	YN
	A	3	3	3	3	2	2	2	2	2	3	2	2	2	31	12		
Total Marks	B	44	44	36	48	41	42	37	34	35	45	45	33	36	517		0.000	**YN**
	A	36	33	35	45	33	34	24	25	26	40	33	33	30	430			
Rank for vegetation	B	3	3	7	1	5	4	6	9	8	2	2	10	7		YP = Significantly change /Positive		
	A	3	6	4	1	6	5	10	9	8	2	6	6	7				
P value		0.00	0.00	0.33	0.82	0.00	0.00	0.00	0.00	0.00	0.10	0.00	1.00	0.00	0.00	YN = Significantly change/ Negative		
Significant change at 5 percent		YN	YN	No	No	YN	YN	YN	YN	YN	No	YN	No	YN	**YN**	No = Significantly no change		

Source -: Field data 2008

1 Not present 2 (1-2 plants per square meter) 3 (3-4 plants per square meter)
4 (More than 4 plants per square meter) * B = Before renovation A = After renovation

Lotus plant that was one of the mostly grown plant species before the renovation has become the sixth abundant plant with renovation. Salvieniya has also decreased to the sixth place. Kekatiya and Water hyacinth can be largely seen even after the renovation as they can grow faster. According to the t-test at 5 percent significance level, there is a difference between the abundance of the aquatic plant cover in the tank which is represented by the total rank marks before and after the renovation of tanks. In additions, there is a difference between the abundance of aquatic plant cover in the tank according to the total rank marks. Dredging and deepening the tanks has influenced the distribution of lotus by reducing its distribution.

The aggregated rank mark has reduced to 430 from 517 after the renovation and it shows a clear reduction in the distribution of plant species grown in the tanks. Figures 2 and 3 shows the changes of aquatic plants, in species wise and tank wise before and after their renovation.

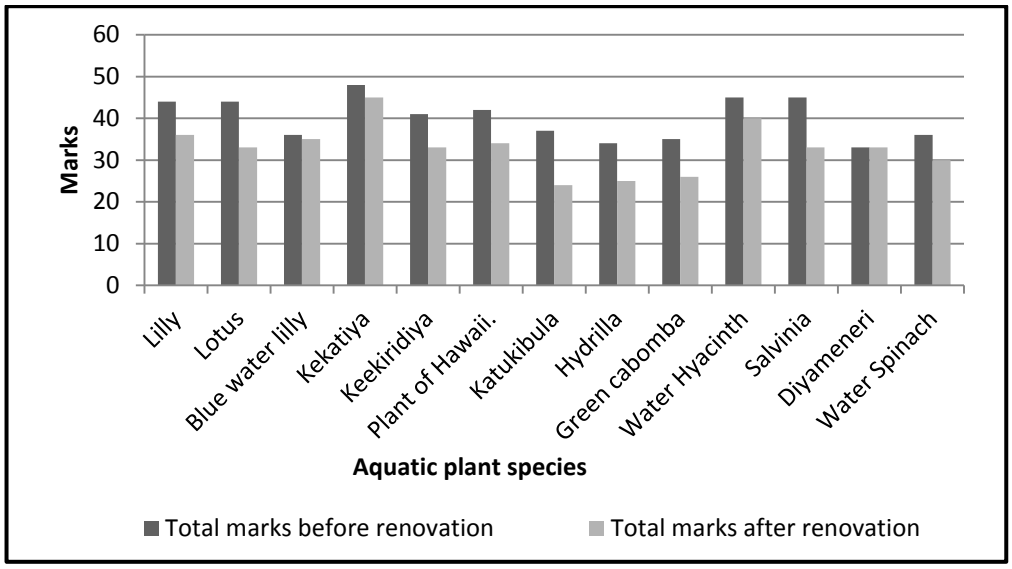

Figure: 2 Evaluation of the abundance of aquatic plant cover in the tank before and after renovation of small tanks using ranking matrix PRA tool

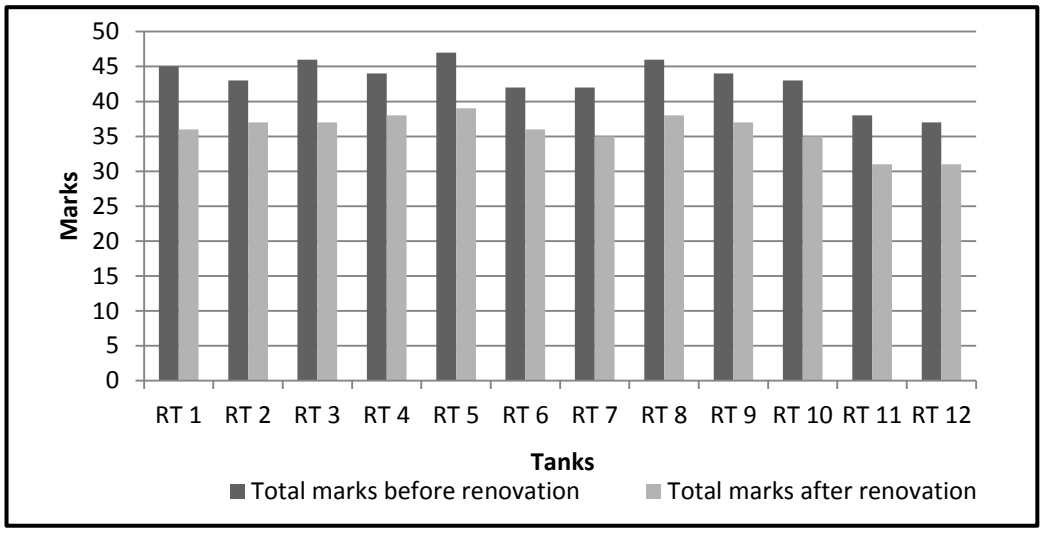

Figure 3 - Evaluation of the tanks according to the abundance of aquatic plant cover in the tank before and after renovation of small tanks using ranking matrix PRA tool

Table 8 shows the changes in the plant population in non-renovated small tanks during past 10 year period. It is revealed that the populations of plant species grown in these non-renovated small tanks remain unchanged while it has changed in renovated tanks. Even though the growth of Salvinia has reduced (Everitt, et al., 2007; Julien and Griffiths, 1998), which has been introduced to prevent the intensive growth of the latter. All the other plants have grown up without any obstacle. Even though some of the species show some changes, it does not demonstrate a significance change. Some plants spread up intensively in quiet water surfaces (Gleason and Cronquist, 1991). Tank

renovation influenced use of the tank for many economic and other proposes. This has created turbulence in water surface and influenced the distribution of aquatic plants.

Table 8 Evaluations of changes of aquatic plant cover in small tanks before 10 years and present situation in non-renovated study tanks

Plant species	Time duration	Villagers' Response (percentage)				Significant change in population*
		1	2	3	4	
Lilly	Before 10 years	0	10	86	4	No
	Present situation	0	20	78	2	
Lotus	Before 10 years	0	18	74	8	No
	Present situation	0	24	66	10	
Blue water lilly	Before 10 years	2	16	76	6	No
	Present situation	0	10	74	16	
Kekatiya	Before 10 years	0	0	70	30	No
	Present situation	0	8	66	26	
Keekiridiya	Before 10 years	0	78	22	0	No
	Present situation	1	82	16	2	
Plant of Hawaii	Before 10 years	0	34	56	10	No
	Present situation	0	32	54	14	
Katukibula	Before 10 years	0	86	14	0	No
	Present situation	0	82	18	0	
Hydrilla	Before 10 years	30	68	2	0	No
	Present situation	34	58	4	4	
Green cabomba	Before 10 years	36	62	2	0	No
	Present situation	40	56	2	2	
Water Hyacinth	Before 10 years	2	36	60	2	No
	Present situation	4	46	48	2	
Salvinia	Before 10 years	0	42	56	2	Yes(N)
	Present situation	26	72	2	0	
Diyameneri	Before 10 years	0	98	2	0	No
	Present situation	2	96	2	0	
Water Spinach	Before 10 years	38	58	4	0	No
	Present situation	46	36	8	0	

Source -: Field data 2008

1 Not present 2 (1-2 plants per square meter) 3 (3-4 plants per square meter)

4 (More than 4 plants per square meter)

Yes (N) = Negative change Yes (P) = Positive change * 5 percent significance level

Transect analysis of aquatic plants in the small tanks

According to the questionnaire survey, field observation and PRA study, several species of aquatic plants including distribution of Blue water lilly, Kekatiya, Water hyacinth and Diyameneri were decreased after the small tank renovation. However, the reduction in aquatic plant population in small tanks has not seriously damaged the ecosystems in and around small tank environments. Water hyacinth and Salvinia that are invasive species were removed during renovated process, which has introduced the ecosystems of small tanks. Even though dredging and removal of aquatic plants from the tank have negatively affected. Some endemic species of aquatic plants, they recover within a short duration.

Frequency, relative frequency, density, relative density and abundance of the aquatic plant species in the renovated and non-renovated small tanks were compared in table 9. According to these results, there are no difference between the values of frequency, relative frequency, density, relative density and abundance of the aquatic plant species in the renovated and non-renovated small tanks, which means that there is no ecosystem damage in relation to the aquatic plant species in the renovated small tanks. However, according to table 9, there is a difference between frequency, relative frequency, density, relative density and abundance calculations of Water hyacinth and Salvinia species. It means that the above aquatic plat populations in renovated small tanks have reduced compared to the non-renovated tanks, which is a positive fact for aquatic plant ecosystems in small tanks.

Table 9 Comparison statistics of aquatic plant populations of renovated and non-renovated tanks in Galgamuwa DS division

		Frequency		Relative frequency		Density		Relative density		Abundance	
Local Name	Species name	RT	NRT	RT	NRT	RT	NRT	RT	NRT	RT	NRT
Kekatiya	*Aponogeton crispus*	64.3	71.4	8.1	8.5	264.3	182.1	11.9	6.7	411.1	255.0
Green cabomba	*Cabomba caroliniana*	10.7	3.6	1.3	0.4	25.0	7.1	1.1	0.3	233.3	200.0
Rigid hornwort	*Ceratophyllum demersum*	35.7	17.9	4.5	2.1	64.3	32.1	2.9	1.2	180.0	180.0
Goonaparadala	*Elodea canadensis*	17.9	10.7	2.2	1.3	21.4	14.3	1.0	0.5	120.0	133.3
Water hyacinth	*Eichhornia crassipes*	67.9	100.0	8.5	12.0	296.4	410.7	13.3	15.1	436.8	410.7

Hidrilla	*Hydrilla verticilata*	35.7	21.4	4.5	2.6	71.4	39.3	3.2	1.4	200.0	183.3
Ketala	*Lagenandra thwaitesil*	3.6	7.1	0.4	0.9	7.1	14.3	0.3	0.5	200.0	200.0
Rendapasi	*Limnophylla indica*	3.6	3.6	0.4	0.4	3.6	3.6	0.2	0.1	100.0	100.0
Gira pihatu	*Myriophyllum indicum*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nelum	*Nelumbo nucifera*	50.0	78.6	6.3	9.4	139.3	217.9	6.3	8.0	278.6	277.3
Olu	*Nemphaea pubescens*	28.6	17.9	3.6	2.1	50.0	25.0	2.3	0.9	175.0	140.0
Nil manel	*Nymphoides indica*	3.6	7.1	0.4	0.9	3.6	10.7	0.2	0.4	100.0	150.0
Diyagowa	*Pistia stratiotes*	57.1	64.3	7.2	7.7	171.4	382.1	7.7	14.0	300.0	594.4
Saveeniya	*Salvinia molesta*	78.6	100.0	9.9	12.0	407.1	589.3	18.3	21.7	518.2	589.3
Vilkatu	*Trapa bispinosa*	10.7	7.1	1.3	0.9	10.7	14.3	0.5	0.5	100.0	200.0
Valisneriya	*Vallineria spiralis*	0.0	3.6	0.0	0.4	0.0	14.3	0.0	0.5	0.0	400.0
Kara	*Chara corellina*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water spinach	*Ipomoca aguatica*	39.3	32.1	4.9	3.8	89.3	71.4	4.0	2.6	227.3	222.2
Ludvigiya	*Ludwigia adscendens*	17.9	42.9	2.2	5.1	60.7	117.9	2.7	4.3	340.0	275.0
Plant of hawai	*Colocasia sp.*	25.0	14.3	3.1	1.7	67.9	32.1	3.1	1.2	271.4	225.0
Nilmonarassa	*Utricularia vulgaivs*	10.7	0.0	1.3	0.0	14.3	0.0	0.6	0.0	133.3	0.0
Hambupan	*Typha angustifolia*	7.1	7.1	0.9	0.9	17.9	14.3	0.8	0.5	250.0	200.0
Aligetor	*Alternanthera philoxeroides*	17.9	35.7	2.2	4.3	39.3	135.7	1.8	5.0	220.0	380.0
Katukibula	*Salmalia insignis*	50.0	82.1	6.3	9.8	228.6	300.0	10.3	11.0	457.1	365.2
Diyameneri	*Musa sapientum*	42.9	7.1	5.4	0.9	103.6	25.0	4.7	0.9	241.7	350.0

Keekiridiya	*Eclipta prostrate*	25.0	17.9	3.1	2.1	60.7	28.6	2.7	1.0	242.9	160.0
Unknown 1		32.1	35.7	4.0	4.3	64.3	57.1	2.9	2.1	200.0	160.0
Unknown 2		32.1	25.0	4.0	3.0	64.3	60.7	2.9	2.2	200.0	242.9
Unknown 3		25.0	3.6	3.1	0.4	57.1	3.6	2.6	0.1	228.6	100.0
Unknown 4		3.6	17.9	0.4	2.1	10.7	35.7	0.5	1.3	300.0	200.0
Total		796.4	835.7	100	100			100.0	100		
T – value			-0.45	-0.05		-1.15		0.40		-0.36	
P - value		0.659		0.962		0.258		0.690		0.725	
Significantly difference at 5 percent		No		No		No		No		No	

Source -: Field transects data 2012

28 number of (5m × 5m) transect plots were used RT – renovated tanks NRT – non-renovated tanks

Table 10 shows the transect plots diversity of aquatic plants in the renovated and non-renovated tanks. The richness (S), evenness (J), diversity (H′) and dominancy (1-J) of aquatic plant species in the renovated tanks are changed compared to the non-renovated small tanks due to renovation. The statistical evaluation of the richness (S), evenness (J), diversity (H′) and dominancy (1-J) of the aquatic plant species in the selected renovated and non-renovated tanks are given in table 10. According to the above results, there is a significant difference between the aquatic plant in the renovated and the non-renovated small tanks, which means that there is a change in aquatic plant population in the renovated small tank.

The removal of aquatic plants, specially the invasive plants from the renovated tanks has positively influenced the ecosystem of the tanks. Further, the removals of the plants beneficially influence some aquatic faunal species. Further, the removal of these plants has prevented addition of aquatic organic matter into the tanks and this has beneficially influenced maintaining the dissolved oxygen level in the tank system. Therefore, the reduction in aquatic plants has more beneficial impacts to the tank system

Table 10 Transect plot diversity of aquatic plants in the renovated and non-renovated tanks

Selected small tanks	Transect plots Indicators	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	For total

RT 5	Diversity (H′)	1.69	1.1	1.22	1.75	1.93	1.77	2	2.05
	Richness (S)	29	22	35	45	32	40	35	239
	Evenness (J)	0.50	0.36	0.34	0.46	0.56	0.48	0.56	0.37
	Dominancy (1-J)	0.50	0.64	0.66	0.54	0.44	0.52	0.44	0.63
RT 9	Diversity (H′)	0.64	1.05	1.01	2.11	1.06	2.24	1.53	2.47
	Richness (S)	3	5	6	24	9	30	14	91
	Evenness (J)	0.58	0.65	0.56	0.66	0.48	0.66	0.58	0.55
	Dominancy (1-J)	0.42	0.35	0.44	0.34	0.52	0.34	0.42	0.45
RT 10	Diversity (H′)	1.33	1.69	1.78	1.92	2.07	2.42	2.34	2.52
	Richness (S)	10	15	15	20	24	36	26	146
	Evenness (J)	0.58	0.62	0.66	0.64	0.65	0.68	0.72	0.51
	Dominancy (1-J)	0.42	0.38	0.34	0.36	0.35	0.32	0.28	0.49
RT 12	Diversity (H′)	1.33	0	0	2.51	1.8	2.42	2.55	2.73
	Richness (S)	6	2	2	53	27	61	50	203
	Evenness (J)	0.74	0.00	0.00	0.63	0.55	0.59	0.65	0.51
	Dominancy (1-J)	0.26	1.00	1.00	0.37	0.45	0.41	0.35	0.49
NRT 4	Diversity (H′)	1.64	0.92	1.33	1.7	1.87	2.32	2.22	2.22
	Richness (S)	11	11	10	23	21	30	23	128
	Evenness (J)	0.68	0.38	0.58	0.54	0.61	0.68	0.71	0.46
	Dominancy (1-J)	0.32	0.62	0.42	0.46	0.39	0.32	0.29	0.54
NRT 8	Diversity (H′)	1.86	1.62	1.86	2.04	1.9	2.26	2.13	2.38
	Richness (S)	22	23	35	35	51	57	41	264
	Evenness (J)	0.60	0.52	0.52	0.57	0.48	0.56	0.57	0.43
	Dominancy (1-J)	0.40	0.48	0.48	0.43	0.52	0.44	0.43	0.57
NRT 9	Diversity (H′)	2.14	2.06	1.92	2.61	1.95	2.07	2.21	2.6
	Richness (S)	42	35	28	29	14	24	25	197
	Evenness (J)	0.57	0.58	0.58	0.78	0.74	0.65	0.69	0.49
	Dominancy (1-J)	0.43	0.42	0.42	0.22	0.26	0.35	0.31	0.51
NRT 10	Diversity (H′)	1.91	2.08	1.81	1.99	1.96	2.08	2.17	2.19
	Richness (S)	18	24	20	28	39	32	44	205
	Evenness (J)	0.66	0.65	0.60	0.60	0.53	0.60	0.57	0.41
	Dominancy (1-J)	0.34	0.35	0.40	0.40	0.47	0.40	0.43	0.59

Source -: Field transects data 2012

Table 11 Comparison statistics of transect plot diversity of aquatic plants in the renovated and non-renovated tanks

Transect plots	Mean for richness		Mean for evenness		Mean for dominancy		Mean for diversity	
	RT	NRT	RT	NRT	RT	NRT	RT	NRT
Plot 1	12	23.25	0.59	0.63	0.42	0.37	1.25	1.89
Plot 2	11	23.25	0.5	0.53	0.5	0.47	0.96	1.67
Plot 3	14.5	23.25	0.54	0.57	0.47	0.43	1	1.73
Plot 4	35.5	28.75	0.58	0.62	0.43	0.38	2.07	2.09
Plot 5	23	31.25	0.58	0.59	0.43	0.41	1.72	1.92
Plot 6	41.75	35.75	0.63	0.62	0.38	0.38	2.21	2.18
Plot 7	31.25	33.25	0.64	0.64	0.36	0.37	2.11	2.18
T - value	-1.41		-2.65		2.87		-2.57	
P - value	0.208		0.035		0.028		0.042	
5 percent significance difference	No		Yes		Yes		Yes	

Source -: Field transects data 2012

The species diversity of the aquatic plants in the renovated and non-renovated small tank ecosystems were calculated using transect data and given table 12. Individual diversities of species in the renovated and non-renovated small tanks are not significantly equal. As a whole according to the comparison statistics, renovation processes are affected to aquatic plants (Table 12).

Table 12 Comparison statistics of the diversity of aquatic plant in renovated and non-renovated tanks in Galgamuwa DS division

Local name	Species name	Pi*PlnPi for Renovate tanks				Pi*lnPi for Non-renovated tanks				Pi*lnPi for total species of RT	Pi*lnPi for total species of NRT
		RT 5	RT 9	RT 10	RT 12	NRT 4	NRT 8	NRT 9	NRT 10		
Kekatiya	*Aponogeton crispus*	-0.21	-0.18	-0.32	-0.23	-0.19	-0.18	-0.11	-0.22	-0.24	-0.18
Green cabomba	*Cabomba caroliniana*	-0.02	-0.08	-0.10	0.00	0.00	-0.04	0.00	0.00	-0.05	-0.02
Rigid hornwort	*Ceratophyllum demersum*	-0.07	-0.18	-0.10	-0.08	0.00	-0.06	0.00	-0.08	-0.10	-0.05
Goonaparadala	*Elodea canadensis*	-0.05	0.00	0.00	-0.06	0.00	-0.05	-0.03	0.00	-0.04	-0.03
Water hyacinth	*Eichhornia crassipes*	-0.30	-0.24	-0.19	-0.26	-0.32	-0.26	-0.28	-0.26	-0.26	-0.28
Hidrilla	*Hydrilla verticilata*	-0.09	-0.21	0.00	-0.10	0.00	-0.06	-0.11	-0.03	-0.10	-0.06
Ketala	*Lagenandra thwaitesil*	-0.04	0.00	0.00	0.00	0.00	-0.04	-0.05	0.00	-0.02	-0.03
Rendapasi	*Limnophylla indica*	0.00	0.00	0.00	-0.03	0.00	-0.02	0.00	0.00	-0.01	-0.01
Gira pihatu	*Myriophyllum indicum*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nelum	*Nelumbonucifera*	-0.11	-0.27	-0.18	-0.14	-0.20	-0.18	-0.17	-0.23	-0.16	-0.20
Olu	*Nemphaea pubescens*	-0.09	-0.11	-0.03	-0.08	-0.04	-0.02	-0.08	-0.03	-0.08	-0.04
Nil manel	*Nymphoides indica*	0.00	0.00	0.00	-0.03	0.00	-0.04	0.00	-0.03	-0.01	-0.02
Diyagowa	*Pistia stratiotes*	-0.18	-0.21	-0.16	-0.20	-0.17	-0.31	-0.19	-0.31	-0.19	-0.27
Saveeniya	*Salvinia molesta*	-0.29	-0.28	-0.31	-0.31	-0.33	-0.33	-0.31	-0.33	-0.30	-0.33
Vilkatu	*Trapa bispinosa*	-0.02	0.00	0.00	-0.05	0.00	0.00	-0.08	0.00	-0.02	-0.03
Valisneriya	*Vallineria spiralis*	0.00	0.00	0.00	0.00	0.00	-0.06	0.00	0.00	0.00	-0.03
Kara	*Chara corellina*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water spinach	*Ipomoca aguatica*	-0.12	-0.08	-0.13	-0.13	-0.14	0.00	-0.08	-0.15	-0.12	-0.09
Ludvigiya	*Ludwigia adscendens*	0.00	-0.16	0.00	-0.17	-0.25	-0.09	-0.14	-0.06	-0.09	-0.13
Plant of hawai	*Colocasia sp.*	-0.17	0.00	-0.08	-0.03	0.00	0.00	-0.14	0.00	-0.10	-0.05
Nilmonarassa	*Utricularia vulgaivs*	-0.04	0.00	0.00	-0.05	0.00	0.00	0.00	0.00	-0.03	0.00
Hambupan	*Typha angustifolia*	-0.07	0.00	-0.03	0.00	0.00	0.00	-0.08	0.00	-0.04	-0.03
Aligetor	*Alternanthera philoxeroides*	-0.08	0.00	-0.08	-0.06	-0.13	-0.19	0.00	-0.18	-0.07	-0.15

Katukibula	*Salmalia insignis*	-0.25	-0.26	-0.26	-0.12	-0.23	-0.22	-0.26	-0.24	-0.22	-0.24
Diyameneri	*Musa sapientum*	-0.15	0.00	-0.10	-0.18	0.00	-0.10	0.00	0.00	-0.13	-0.04
Keekiridiya	*Eclipta prostrate*	-0.12	0.00	-0.13	-0.05	-0.11	-0.04	-0.05	0.00	-0.09	-0.05
Unknown 1		-0.04	-0.08	-0.13	-0.13	-0.11	-0.09	-0.08	-0.05	-0.10	-0.08
Unknown 2		-0.04	-0.11	-0.08	-0.15	0.00	0.00	-0.21	0.00	-0.10	-0.08
Unknown 3		-0.07	0.00	-0.10	-0.13	0.00	0.00	-0.03	0.00	-0.09	-0.01
Unknown 4		-0.05	0.00	0.00	0.00	0.00	0.00	-0.15	0.00	-0.02	-0.06
Total		-2.70	-2.47	-2.52	-2.73	-2.22	-2.38	-2.60	-2.19	-2.79	-2.55
Richness (S)		239	91	146	203	128	264	197	205	679	794
H max		5.48	4.51	4.98	5.31	4.85	5.58	5.28	5.32	6.52	6.68
Evenness (J)		0.49	0.55	0.51	0.51	0.46	0.43	0.49	0.41	0.43	0.38
Dominancy (1-J)		0.51	0.45	0.49	0.49	0.54	0.57	0.51	0.59	0.57	0.62
Shannon Winner diversity (H')		2.70	2.47	2.52	2.73	2.22	2.28	2.60	2.19	2.79	2.55
T - value										**-0.46**	
P - value										**0.0.049**	
Significantly difference at 5 percent										**Yes**	

Source -: Field transects data 2012

References

Aheeyar, M.M.M. 2005. Renovation of minor tanks - problems and prospects, Economic Review, pp 17-20, Central Bank, Colombo, Sri Lanka.

Ausadahami, U.B. 1999. "Wewa"(Sinhala), Siri Printers, Higurakgoda, Sri Lanka.

Dharmasena, P.B. 1991. Present use of land and water resource in village tank farming. Journal of Soil Science Society of Sri Lanka, 7:7-17.

Dharmasena, P.B. 1995. Kattakaduwa; A potential land for agro-forestry systems development in Sri Lanka. In H.P.M. Gunasena (ed.) Proceedings of the 6th Regional Workshop on Multipurpose Trees, pp 96 - 105, University of Peradeniya, Peradeniya, Sri Lanka.

Everitt, J.H. Lonard, R.L. and Little, C.R. 2007. Weeds in South Texas and Northern Mexico. Lubbock: TexasTechUniversity Press.

IUCN 2007. The 2007 red list of threatened fauna and flora of Sri Lanka, The World Conservation Union and Ministry of Environment and Natural Resources, Colombo, Sri Lanka.

MaddumaBandara C.M. 1980. Water management under minor irrigation schemes in the Dry Zone in Sri Lanka. 24th International Geographical Congress. Abs. 12- 220-221.

MaddumaBandara C.M. 1985. Catchment ecosystems and village tank cascades in the Dry Zone of Sri Lanka. In Lungqvist, U. Lorm and Falknmark,M (ed.) Strategies for River Basin Development. Germany: J. Reidel Publishing Company Pp. 99 – 103.

Tennakoon, M.A.U. 2002. Small tanks cascades as development units in the Dry Zone in Sri Lanka, Economic Review, 21-29.

Tennakoon, M.A.U. 2004. Tanks are not mono functional they are multifunctional, Proceedings of the Symposium, Hector Kobbekaduwa Agrarian Research and Training Institute, Colombo.