

## **Water Conflicts among Different Water Users and Uses in the Hakwatuna Oya Watershed in the Deduru Oya Basin, Sri Lanka**

N.G.R. Saumyarathna\*, E.R.N. Gunawardena<sup>1</sup> and N.D.K. Dayawansa<sup>1</sup>

Postgraduate Institute of Agriculture  
University of Peradeniya  
Sri Lanka

**ABSTRACT:** *Scarcity of water is the main problem of agriculture and other livelihoods of Hakwatuna Oya watershed in Deduru Oya basin which leads to conflicts among different water users and uses. With this background, a study was conducted to find water conflicts and factors leading to such conflicts among different water users and uses in Hakwatuna Oya watershed. Various field research methodologies including field surveys, focus group discussions, and interviews with farmers, officials and community leaders were used to gather information. In addition, documentary evidence, such as minutes of the monthly Project Management Committee meetings during 2012 Maha to 2014 Yala seasons were perused to study the conflicts within the irrigation command. Conflicts between head-end and tail-end farmers, farmers and officers, farmers of irrigation command area and in the catchment, farmers of irrigation command area and fisherman and farmers of irrigation command and outside of the command area were found during the study. Conflicts arise mainly due to water scarcity, and number of conflicts is comparatively higher during Yala (dry) season. Illegal water tapping is the most common reason for conflicts among farmers. Poor attitudes of farmers, weakness of existing land and water rights, non-implementation of existing law primarily due to political interference, encroachments and inadequate institutional arrangement for water resource management are found to be contributing factors to water conflicts. The socio-economic and cultural factors, such as gender and religion also play roles in existing water conflicts.*

**Keywords:** *Conflicts, gender, Hakwatuna Oya watershed, irrigated agriculture, water scarcity*

### **INTRODUCTION**

Water plays a pivotal role in economic activity and in human well-being due to the importance of water in production such as irrigation and in domestic use (Crow and Sultana, 2002). Irrigated agriculture is the main consumer of fresh water. However, irrigation schemes are not isolated but part of a whole basin with other water users. A “water short” basin tends to have more conflicts if water is not properly allocated among different users (Lecler, 2004). Water flows in natural basins by gravity and those who live upstream could technically control the flow of water. This can be the basis for water conflicts (Gasteyer, 2009). It has been reported that water conflicts are results of competition for water resources mainly during the dry season (Gichuki, 2002; Kulkarni, 2011).

---

<sup>1</sup>Department of Agricultural Engineering, Faculty of Agriculture, University of Peradeniya, Sri Lanka

\*Corresponding Author: ngrsauyarathna@gmail.com

Conflict can be defined as disagreement over the appropriate course of action to be taken in a particular situation (Mitchel, 1997). Importance of water in sustaining human livelihoods can indirectly link it to conflict and conflict is a usual part of life (Carius *et al.*, 2004). Many social, cultural and economic factors determine a person's access to water (Kulkarni, 2011). Gender is one of the major factors which determine access to water (Zwarteveen, 1994). Water conflicts can be classified according to the parties and sectors involved and level of conflicts (Abuzeied and Meguid, 2006).

Seasonal and spatial scarcity of water is the main problem of agriculture and other livelihoods of *Deduru Oya* basin in Sri Lanka. *Hakwatuna Oya* irrigation scheme, the largest irrigation scheme within *Deduru Oya* basin suffers more than other irrigation schemes in this basin due to water shortage (Somarathne *et al.*, 2003). Decreased rainfall and reduction of inflow into tanks due to blocking of natural water courses were cited as some of the reasons which aggravate this water scarcity problem (Samaranayake, 2001). However, a recently conducted study has shown that there is no change in rainfall in the watershed (Perera, 2015). Therefore, anthropogenic impacts appeared to play a major role with regard to water scarcity compared to natural phenomenon.

### **Justification and Objectives for the Study**

*Hakwatuna Oya* irrigation system constructed in the 4<sup>th</sup> Century A.D was later restored by the Irrigation Department in 1964. The total catchment of the reservoir is about 6880 ha, of which there was 5024 ha of natural forest owned by state at that time and the balance was privately owned (Samaranayake, 2001). Three main tributaries within the catchment feed the reservoir. The longest stream (*Hakwatuna Oya*) is 6.1 km and others are less than 5.0 km (Figure 1). The total area of *Hakwatuna Oya* Watershed consists of three major components; 6880 ha of reservoir catchment, 334 ha of reservoir and 2578 ha of irrigation command.

With the restoration in 1964, more than 1600 farm families were settled by government within the command area. At present, there are 14 farmer organizations and around 2500 farmer families within the command along with the expansion of specified land extent from 2093 to 2578 ha (Source: *Hiriyala* Irrigation Office, 2015) indicating that, per capita land holding has decreased over the years. However, a substantial change has taken place within the catchment. In 1964, 5024 ha of the catchment was covered by natural forest and there were only 136 farmer families within the privately owned land. The forest and other state lands have been encroached for shifting cultivation whilst village expansion programmes were promoted by the authorities. The extent of forest has reduced from 5024 ha in 1964 to 1135 ha in 2014; a reduction of 3889 ha within five decades (Samaranayake, 2001; Pelpitiya, 2015). To stabilize agricultural production and to reduce crop losses, farmers within the catchment constructed agro-wells. It is reported that there are more than 1890 agro-wells within the catchment by 2015 (Pelpitiya, 2015). There was another group of farmers within the catchment who withdraw water directly from streams which feed the reservoir.

The above description indicates that there are mainly three different water users in the watershed; farmers in irrigation scheme, farmers who use agro-well and farmers who directly abstract water from streams. The access to water and the water rights of these three groups of farmers are found to be different. The farmers in the irrigation command are the legitimate users of water through the Irrigation Department according to the Irrigation Ordinance No 32 of 1946, whilst the encroachers in the catchment have no legal water rights. Though some of the agro-well farmers with Land Development Ordinance (LDO) permits could claim for

groundwater within their lands, the encroachers who use groundwater are questionable. Farmers who abstract water from streams (in-stream users) violate the regulations according to the Land Development Ordinance of 1947 which prohibits anyone to abstract water from flowing streams without the permission of Government Agent. Use of this common resource of water, which has become scarce over the years by three different groups would very likely to have water conflicts within and among the groups. In addition there are different uses of water in addition to irrigation such as domestic use and fisheries. With this background, a study was conducted to find water conflicts among different water users along with reasons for such conflicts within the *Hakwatuna Oya* watershed.

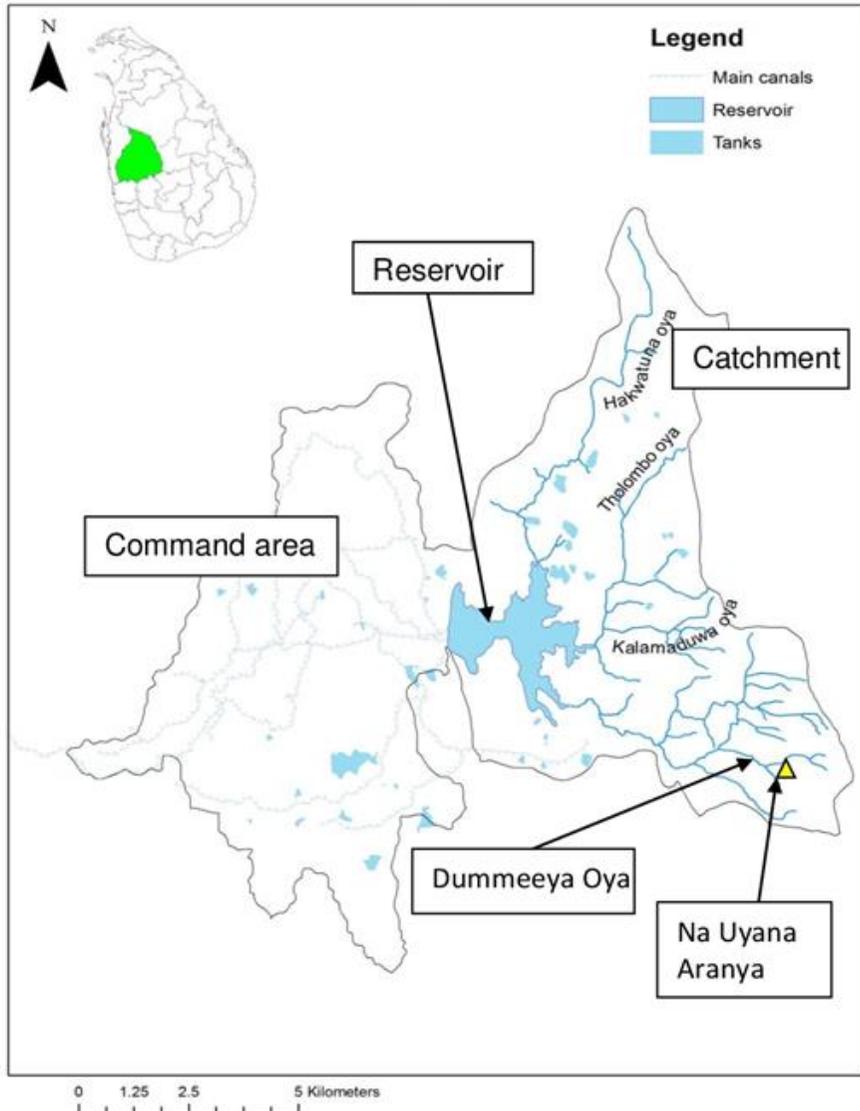


Figure 1. *Hakwatuna Oya* watershed

## METHODOLOGY

Key informant discussion was held with Residential Project Manager (RPM), who is directly involved with farmer organizations to identify the nature of conflicts in *Hakwatuna Oya* irrigation scheme. Four farmer organizations from both left bank and right bank of the irrigation system were selected based on information gathered from the RPM. Office bearers such as President, Secretary and Water master of the selected farmer organizations were interviewed and background information was collected. Minutes of monthly project management committee meeting of *Hakwatuna Oya* irrigation scheme during 2012 *Maha* to 2014 *Yala* seasons and minutes of meetings of selected farmer organizations were referred. To study the water conflicts, four *Grama Niladari* (GN) Divisions were selected from 17 GN divisions present in the *Hakwatuna Oya* scheme. Agricultural Research & Production Assistants, *Grama Niladari*, officers of the scheme and office bearers of the four selected farmer organizations were interviewed to obtain information related to water conflicts in *Hakwatuna Oya* scheme. Collected information on water conflicts were compiled, categorized, and some conflicts were selected for detail study to be presented as case studies. The identified stakeholders of those selected conflicts were separately interviewed to understand the underline causes of conflicts.

## RESULTS AND DISCUSSION

### Water Conflicts in *Hakwatuna Oya* Irrigation Scheme

Water as a critical input determines the crops yields and hence the livelihood of farmers in the *Hakwatuna Oya* irrigation scheme. It was found by other researchers that 78% of the farmers have no other income source except crop production in the *Hakwatuna Oya* irrigation scheme (Lakmali, 2015). Therefore, farmers are ready to fight and steal water as long as they have access to water. There are several instances of open conflicts and stealing water recorded by Farmer Organizations in *Hakwatuna Oya* watershed.

According to the information collected, water conflicts within *Hakwatuna Oya* irrigation scheme can be categorized in to five, as listed below.

- Conflicts between head-end and tail-end farmers
- Conflicts between farmers and officers
- Conflicts between farmers of irrigation command and farmers in the catchment
- Conflicts between farmers of irrigation command and fishermen
- Conflicts between farmers of irrigation command and farmers outside of the command area

#### Conflicts Between Head-end and Tail-end Farmers

Conflicts between head-enders and tail-enders are very common in the *Hakwatuna Oya* irrigation scheme. These kinds of conflicts arise at D-canal and field canal level. There is one pole (orifice) through which water is issued from field canal to irrigate 3 ac (about 1.3 ha) of paddy land in *Hakwatuna Oya* irrigation scheme. Due to land fragmentation, these 3 ac of paddy land are cultivated by more than 3 to 4 farmers. Breaching of the field bunds by the downstream farmer before his immediate upstream farmer to get sufficient irrigation water leads to conflicts among neighbouring farmers.

The policy of water distribution within the irrigation systems is to issue water to areas far away (tail-enders) from the reservoir first whilst lands closer to the reservoir receives water at last (head-enders). Therefore, head-enders have to wait until tail-enders irrigates their fields. However in the period of water shortage, it was very difficult to implement this policy.

According to studies conducted in year 2015, most farmers felt insecure and felt that they may not get adequate water after tail-enders receive water during the water shortage periods. Paddy farmer always like to see their fields with standing water and continue to irrigate before providing an opportunity to other farmers. This leads to overuse of irrigation water. Therefore, poor attitude of farmers with regard to use of irrigation water lead to regular water conflicts in the *Hakwatuna Oya* irrigation scheme.

Uncertainty could also interfere with the existing policy of water distribution which ultimately leads to conflicts. Such type of intense conflict was recorded in 2014 *Yala* season. *Sisil Pokuna* farmer organization was to receive water lastly because their fields are located close to the *Hakwatuna Oya* reservoir and they had to wait until irrigation water was issued to tail-end farmers. However, in this period of severe water shortage, they felt that there may not be adequate water available for them after issuing water to the tail-enders. They blocked the water flow and tried to irrigate their fields first. The irrigation officers were able to distribute water to tail-enders only after the intervention of Police officers.

#### Conflicts between farmers and officers

Sometimes, conflicts arise between groups of farmers and officers of the Irrigation Department though such conflicts are very rare and isolated. In general, there were less possibilities for conflicts between farmers and officers as a result of allowing farmers to participate in the decision making process through farmer organizations. There was no evidence of conflicts between RPM, his staff and farmers since they interact very closely with farmer organizations. RPM and his staff is involved with the socio-economic aspects whilst, technical staff of the Department of Irrigation is responsible for flow control. The conflict arises with the latter group.

In 2014 *Yala* season, a group of the farmer resorted to violence and physically assaulted one of Head Water Master and Work Superintend of *Hakwatuna Oya* irrigation scheme. Water level of the reservoir was significantly low during this season and only farmers of the right bank were issued with irrigation water as decided according to *bethma* system. Groups of farmers of *Bogolla Yaya Hathara* farmer organization in the right bank tried to get water by opening the sluice gates without permission of irrigation officers. Intervention of field officers to prevent this illegal tapping of water led to this conflict between farmers and irrigation officials.

#### Command area farmers vs. encroachers of catchment area

One of main causes of water problem within *Hakwatuna Oya* watershed has been identified as the destruction of land adjacent to upstream of the tank and the catchment. Encroachers in the upstream reservation of the tank and tank bed, cultivate commercial vegetables and they sometimes (mainly during dry season) directly pump water from the *Hakwatuna Oya* reservoir using diesel pumps. Farmers in the irrigation command, knowing the impact of such destructive practices, always have conflicts with the encroachers. The Central Farmer

Organization of *Hakwatuna Oya* irrigation scheme has complained against these illegal encroachers to police. As a result, those illegal water users were arrested by police, but released due to political intervention.

#### Irrigated agriculture vs. fisheries

Conflicts between different water uses groups, such as fisheries and irrigated agriculture exists within the irrigation system. There is an inland fishery organization associated with *Hakwatuna Oya* reservoir. Inland Fish Farmer Cooperative Society set up by the ministry of fisheries in 1985 helped to organize, promote, maintain and harvest fish stock while ensuring the sharing of benefits within the fishing community.

Though farmer organizations and fish farmer committee represent different uses, both parties depend on the same water available at the *Hakwatuna Oya* reservoir. Fishermen argue that water below the sluice level is needed for the growth of fish and fish nurseries while farmers argue that even last drop of water should be used for crop production. Though it is technically difficult to release water through the sluice when the water level reaches lower level of the sluice, farmers use pumps to abstract water. This type of conflict is induced only when there is a serious water shortage. In general, priority goes to farmers compared to the fishing groups.

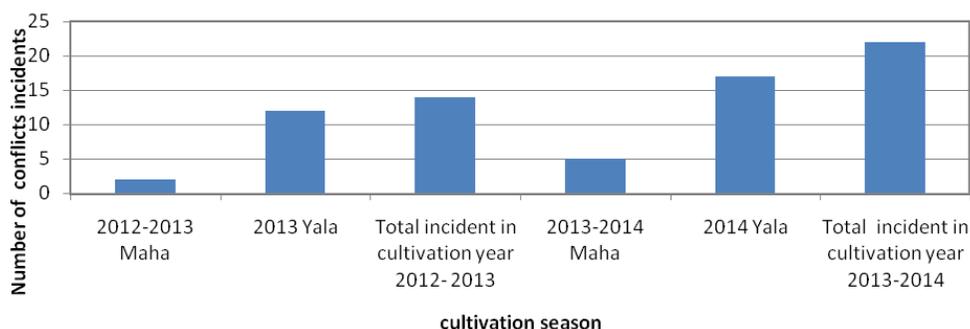
#### Farmers within and outside the command area

Most of conflicts between farmers in the irrigation command and outside the command are due to Illegal water trapping by the latter from irrigation canals. While water is flowing downstream through canals, farmers who are not given lands within the irrigation command use pipes to take water for their paddy fields. This often happens at night and legitimate farmers do not realize that the irrigation flows to their fields have been reduced.

Pipes and pumps used for illegal water tapping are seized by police. It is reported that those who are arrested are released without any charges due to political intervention (Minutes of water management committee, 2013, unpublished). Encroachment of reservation land of *Hakwatuna Oya* irrigation scheme by outsiders is another serious issue which leads to conflicts between farmers within the irrigation command and outside of it.

#### Recorded conflicts

The minutes of the monthly Project Management Committee meetings from 2012 *Maha* to 2014 *Yala* seasons were perused in order to identify the conflicts within the irrigation command area. Figure 2 shows that number of conflicts reported within the irrigation command varies with cultivation seasons. As expected, the number of conflicts is comparatively higher during *Yala* (dry) season. Number of different types of water conflicts recorded is shown in Table 1. Illegal water tapping is the most common conflicts among farmers.



**Figure 2. Number of reordered conflict incidents in 2012-2013 and 2013-2014 cultivation years**

**Table 1. Number of incidents reported in different types of water conflicts during 2012-2013 and 2013-2014 cultivation years**

Different types of water conflicts	Number of reported incidents	%
Illegal water tapping	10	28
Encroachment of land , canals and reservation	9	25
Water distribution within the system	7	19
Malfunctioning of irrigation structures	6	17
Damage to the irrigation structures	3	8
Disrupt the duty of irrigation officers including and physical harassment to officers	1	3
Total	36	100

A selected conflict was further studied as a case which is described below.

Case study 1: Gender and restricted accessibility to water in *HakwatunaOya* irrigation command (*names of persons given in the descriptions are not real to avoid identification*)

*Somalatha* is a 55-year old woman in “*Nakkaththagama*” village and lives with her son, daughter-in-law and two little grandchildren. Her husband, *Sunil* has gone to a Middle Eastern country in 2014 to earn a living. In 2015 *Yala* season, her son and daughter-in-law left the home to work in a garment factory outside the village. *Somalatha* was left behind in her house with one of her grandchildren.

*Somalatha*’s husband *Sunil* owns around one acre of paddy land in *Hakwatuna Oya* irrigation scheme, given to him by his parents. Out of this, 0.5 acre of land was pawned to another farmer and the balance 0.5 ac was earlier cultivated by *Sunil*. Since her husband and son were away, *Somalatha* decided to cultivate the land in 2015 *Yala* season. She started paddy cultivation with the onset of rainfall. All the labour intensive activities such as cleaning and re-plastering of bunds and preparing shallow channel system to drain paddy fields were done by *Somalatha* herself. Difficult to find labourers during the land preparation period and high cost of labourers have compelled her to do this work by herself.

The most challenging operation in paddy cultivation is to provide irrigation at right time with sufficient quantity. *Somalatha's* paddy field is located at the tail end of LB-4 field canal. *Somalatha* had to go to the field in early in the morning with foods (breakfast, lunch and tea) and spent the whole day to wait for her rotation. There is a pole (orifice) from field canal to the three acres of paddy land. *Somalatha* and *Kamal* (younger brother of *Somalatha's* husband) receive water from the same pole. *Somalatha* has to wait for her turn and receives water only after *Kamal* completes irrigating his field. Problems arose during the flowering stage of paddy because water was released at night. *Somalatha* could not stay in the field at night due to security reasons and to look after the grandchild. *Kamal* had diverted water to the drainage canal after he irrigated his portion of the land. Many times, she complained to the field canal Water master about this issue. Since there was no action, she complained to main Water master who was also the President of the farmer organization. The Water master's advice to *Kamal* has backfired on her. *Kamal* scolded her under the influence of alcohol. In addition to losing money, *Somalatha* had to undergo mental stress. *Somalatha* did not give up and complained to officials, such as RPM, Technical Officers of Irrigation Department, and other officers including Police. By the time the action was taken, she could get only the last rotation and lost about 60% of her potential paddy yield due to water stress.

Though this appears to be a simple case of allocating water, the problem needs to be understood from different angles. *Somalatha's* husband is a member of a family with seven siblings, five (5) sisters, one younger brother and one elder brother. *Kamal* is the youngest in the family. *Sunil's* farther, gave the part of paddy land to *Sunil* without a title deed. *Sunil* cultivated this paddy land for a period of more than 30 years. Other part of paddy land was cultivated by *Kamal* after the death of their farther. *Kamal* claim that he has the right to family property compared to other family members since he is the youngest in the family (that is a cultural norm). *Somalatha* was of the opinion that if this land was given to *Kamal*, he would not give it back to them. The relatives, such as her mother- in-law also disapproves her cultivating the land since she believes that men only should cultivate the land.

This entire episode has affected *Somalatha* very badly. She pawned her gold jewellery to the bank to get money for cultivation of paddy. She lost more than 60% of the potential yield, and what was left is required for family consumption. She did not have other income and her husband also did not send her money since he was misinformed by her mother-in-law. *Somalatha* has sold her sewing machine and recovered the jewellery. She was fed up due to all these problems, gave the land to her son and left the village. Now she is said to be working as a domestic helper in Colombo.

### **Water Conflicts in Hakwatuna Oya Catchment**

There are different types of water users and uses in *Hakwatuna Oya* catchment. People use stream water for drinking and washing purposes whilst some abstract water directly from stream for irrigation purposes. Groundwater is also used as a supplementary water source for the irrigation. The streams in *Hakwatuna Oya* catchment are seasonal. There is no scarcity of water in the wet seasons whilst the streams go dry during dry seasons. This water scarcity leads to conflicts between different water users. Conflicts are relatively low among agro-well users since they do not share a "common" resource. The agro-wells are constructed within farmer's lands and the groundwater rights are linked to land rights. Sharing of surface water is the most common type of conflicts among different user groups. Unlike in the irrigation command, where farmers are provided with water by the Department of Irrigation, the access

to water resources in the catchment is determined by many factors. The case study described below indicates the complexity of the problem.

Case study 2: Conflicts between irrigation water and drinking water users on *Dummeeya Oya* (a tributary of *Hakwatuna Oya*)

*Dummeeya Oya*, one of the tributaries which feed *Hakwatuna Oya* reservoir provides water for drinking, bathing, washing etc. to people in *Angulgamuw* and *Polgahangoda* GN divisions. Farmers also directly pump water from this stream to irrigate their crops. In wet season, there is no competition between different water users. However, there is less or no flow during the dry season and competition between different water users are very high. People are compelled to dig pits on the stream bed, installed container or make sand barriers to collect water. This situation leads to many water conflicts.

*Na Uyana Aranya* ('Ironwood Grove Forest Monastery') is one of the oldest Buddhist forest monasteries in Sri Lanka, dating back to 3<sup>rd</sup> Century BC. In 1997 a group of monks revived the old monastery located within the *Hakwatuna Oya* catchment and made it as one of the largest monasteries in the country. It has an *Uposatha* hall, a meditation hall, a dining hall and alms food hall, a library and offices, in addition to about 80 *kutis* (monks' residences). It is also one of the main international monasteries in Sri Lanka, with about 25 residential foreign monks. Compared to an ancient monastery which had few caves and a beautiful forest with many big Ironwood trees in the past, many development activities are going on at the hermitage at present. All water needs such as drinking, cooking, sanitation and construction activities of the *aranya* is fulfilled by *Dummeeya Oya*.

Three are nearly 10 farmers who directly pump water from *Dummeeya Oya* as supplementary water source. In addition, 23 farmers belong to "*Katupila Dalupotha*" minor irrigation scheme depends on *Dummeeya Oya*. Farmers reported that there was no water scarcity about 15 years ago and they received sufficient amount of water for both *Maha* and *Yala* seasons. Most of farmers cultivated paddy using water from *Dummeeya Oya*. According to them, bulk water abstraction by *Na Uyana Aranya Senasanaya* from upper part of *Dummeeya Oya* during early days was not significant since there were few monks with no development activities. During the recent past, there have been many development activities leading to construction of new buildings. In addition, number of resident *bikkus* and those visiting the monastery has increased many times. This has led to increased water use by the monastery. The resultant impact on this water shortage led farmers to cultivate only about 10% of the cultivable land during the *Yala* season. However, farmers are reluctant to take action since majority of them are Buddhists. Depriving water to the monastery is considered as a sin according to the religion.

About five years ago, Farmer Organization directly complained to *Polpithigama* police station, though they did not intervene to resolve the problem. Farmers reported this problem to many individuals/institutions which they thought could interfere and resolve the issues, such as Agrarian Research and Production Officers from *Polgahangoda* and *Angulgamuwa*, Agrarian Development Officer of the Agrarian Development Department of *Madahapola* and District Secretary of *Polpithigama*. Farmers reported that, no government agencies or persons paid any attention towards their problems since it is a religious matter. Farmers are of the opinion that officers are not willing to go against the temple since the society may looked down on them.

However, there is a justifiable intervention with regard to the action taken by the government officials. According to the existing law (Land Development Ordinance of 1947), no one is allowed to abstract water from a stream using mechanical devices (people are allowed to abstract water using a bucket for household purposes and feeding the livestock). Therefore, abstracting water from *Dummeeya Oya* using water pump is considered as illegal.

The above two case studies, described within the irrigation command and catchment shows that conflicts cannot be resolved since there were many issues to be addressed before putting a conflict resolution mechanism in place. There were issues with regard to land titling, both in irrigation command and catchment. Most of the farmers have user rights. Alienating lands to the second generation is also a problem. There are also no clear water rights due to lack of a water policy and associated acts and regulations. The responsibilities with regard to land and water management are scattered around many institutions and organizations so that no one is accountable/responsible to take action so that they can evade in addressing of complex problems. However, it is imperative to take note of these issues as early as possible since problems associated with water scarcity problems in *Hakwatuna Oya* watershed are going to get worse with time.

## CONCLUSIONS

The results show that, water conflicts exist within the irrigation command as well in the catchment of *Hakwatuna Oya* watershed. Conflicts between head-end and tail-end farmers, farmers and officers, farmers of irrigation command and in the catchment, farmers of irrigation command and fishermen and farmers of within irrigation command and outside of the command area were observed during the study. Water scarcity is the main reason which leads to water conflicts. Poor attitudes of farmers, weakness of existing land and water rights, non-implementation of existing law primarily due to political interference, encroachments, inadequate institutional arrangement of water resource management are also considered as factors contributing to water conflicts. The socio-economic and cultural factors, such as gender and religion also played different roles in existing water conflicts. In a given watershed, different users and uses cannot be isolated from each other since all of them share a single resource, *i.e.* water. If interventions are not taken to introduce basic principles of integrated water resources management with the involvement of different stakeholders the existing conflicts would be further escalated in the future. Establishment of land and water rights, proper institutional arrangements for water allocation and monitoring, communication between and among sectors, quick and efficient conflict resolution mechanism with improved governance, needs to be in place to avoid conflicts.

**Acknowledgement:** *This work was carried out with the aid of a grant from the International Development Research Centre, Ottawa, Canada. Their financial support is greatly acknowledged.*

## REFERENCES

Abuzeied, K. and Meguid, A.A. (2006). Water Conflicts and Conflict Management Mechanisms in the Middle East and North Africa region. Centre for Environment and Development for the Arab Region and Europe (CEDARE).

Carius, A., Dabelko, G.D. and Wolf A.T. (2004). Water, Conflict, and Cooperation, policy brief. The United Nations and Environmental Security.

Crow, B. and Sultana, B. (2002). Gender, Class, and Access to Water: Three Cases in a Poor and Crowded Delta. *Society and Natural Resources*, 15, 709 - 724.

Gasteyer, S. (2009). Water Conflict, resources management, and resolution: Trust, Tools, Technology, and Politics. Inter-community Peace and Justice Center.

Gichuki, F.N. (2002). Water scarcity and conflicts : A case study of the upper ewaso Ng'iro North Basin. in: The changing face of irrigation in kenya: Opportunities for anticipating changes in Eastern and Southern Africa. International Water Management Institute, Colombo, Sri Lanka.

Kulkarni, S. (2011). Gender and Irrigation in South Asia. [ Accessed on :2016/1/2 ]. Available at:  
<http://iipdigital.usembassy.gov/st/english/publication/2011/07/20110718161237yeldnahc0.2935231.html#axzz4ERfp3Tw1>

Lakmali, W.A.S. (2015). Sustainability based comparative performance assessment of three major irrigation system in *Ddeduru oya* basin. M.Phil thesis (unpublished). Postgraduate Institute of Agriculture, University of Peradeniya, Sri Lanka.

Lecler, N. (2004). Methods, tools and institutional arrangements for water conservation and demand management in irrigated sugarcane. In: Proceedings of Conserving Soil and Water for Society: Sharing Solutions. International Soil Conservation Organisation (ISCO), Brisbane.

Mitchell, B. (1997). Resource and Environmental Management. Addison Wesley Longman Limited. United Kindom. [Accessed on: 20/7/2015]. Available at:  
<http://www.waterencyclopedia.com/Ce-Cr/Conflict-and-Water.html#ixzz41tpRXysT>.

Pelpitiya, I.P.S.K. (2015). Impact of land use and land cover changes on ecosystem and food security in *Hakwatuna Oya* watershed in *Deduru Oya* basin. M.Phil. thesis (unpublished). Postgraduate Institute of Agriculture, University of Peradeniya, Sri Lanka.

Perera, A.C.S. (2015). Impact of climate variability on water availability and paddy productivity in the “Hakwatuna Oya” irrigation scheme in Sri Lanka. M.Phil. thesis (unpublished). Postgraduate Institute of Agriculture, University of Peradeniya, Sri Lanka.

Samaranayake, W.R. (2001). Impact of land use changes on watershed in dry and intermediate zones of sri lanka (case study from Kurunegala District). Agricultural University of Norway.

Somarathne, P.G., Jinapala, K., Perera L.R., Ariyaratne, B.R., Bandaragoda, D.J and Makin I.W. (2003). Developig effective institutional for water resources management: A case study in the *Deduru Oya* Basin. International water management institute, Colombo, Sri lanka.

Zwarteveen, M.Z. (1994). Gender issues, water issues: A gender perspective to irrigation management. International Irrigation Management Institute (IIMI), Colombo, Sri Lanka.