

Stream Reservations are at Risk? : A Case Study on the Agro-Well Development in the Dry Zone of Sri Lanka

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Abstract: *The emergence of Agro-well based agricultural systems has started in low line areas of the Dry Zone of Sri Lanka, due to the easy access of shallow groundwater. It became very rapid after 1989 and this has been discussed among the research community as well as among regional resources planners. Now, there is a common belief that the Agro-well based land development has drastically changed the overall land use in the Dry Zone. Especially the “Stream reservations” are one of the important components in the Dry Zone land use and these have been contributing a lot of biological services. The existence of these reservations has conceptually ensured with the empirical knowledge of the farmers as well as current legislative supports. Accordingly, this study was conducted to examine whether there is an impact of Agro-well development on stream reservations and whether the impact is significant. The study was conducted covering 20 mini basins consisted of 20 tank cascades in the North Central Dry Zone. Computing the Agro-well density in tank cascades, an Agro-well survey in stream reservations, maps interpretations (Geo eye 1 satellite images and GIS maps) and significant tests were also used for the study. It was revealed that although there are relevant regulations to allocate the stream reservations, Agro-wells have been constructed in stream reservations and a number of damages have been done recently. Furthermore, according to the differentiated mean T test, Agro-well availability in stream reservations has been significant (P value = 0.0044).*

Keywords: Agro-wells, Dry Zone, Stream reservations, Legislative supports

1. Introduction to the Study

The concept of Agro-well constructions for agricultural purposes of the dry zone of Sri Lanka was introduced long before with the groundwater based experimental studies of Farmer (1951, 1957, 1959) [2], Sirimanna (1952), Panabokke (1959, 2002) [6] Fernando (1973) [3] and Madduma Bandara (1973, 1977) [5]. However with the above studies, farmers in the dry zone started to use the shallow groundwater of the hard rock aquifers for cultivation through shallow large diameter wells (dug wells), which are popularly known as “Agro wells” (Pathmarajah, 2002) [7]. Further, Agro-wells were introduced by the Agricultural Development authority and provincial councils in order to provide access to shallow groundwater in the Dry Zone (Perera, Nianthi, and Madduma Bandara, 2016) [11]. In addition to that, a few local Non Governmental Organizations also extend subsidies and subsidized loans for the construction of Agro-wells (Kikuchi et al. 2003) [4].

Historically, the land use pattern of the Dry Zone of Sri Lanka, based on the tank systems has been transformed from a natural ecosystem into an agro-ecosystem due to the unique tank system as well as the stream network. Dharmasena (2010) [1] also revealed that the ecosystems in the vicinity of tanks play a vital role in the dry zone environment including the maintaining of biodiversity. However, recently the diffusion of Agro-wells in low line areas including in the vicinity of stream network within the tank cascades, has been at a significant level (Perera, 2011) [8].

The schematic representation of tanks and stream network in the dry zone shows the hydrologic interlink as well as the ecological interlink along the small valley. They comprise of ideal bio-diversity spots and these ensure the maintenance of

ecological balance (Perera and Nianthi, 2016) [10]. Forest reservations, including stream reservations are important land use components in the Dry Zone and these have been contributing a lot of services to the watershed processes. Stream reservations are the “forest strips along the streams covering both stream/river banks”.

According to the Land Development Ordinance No.19 of 1935, land regulations-15-10-1948 No 9912 and the Land Development Ordinance of 1970 provide the necessary legislative support for the maintenance of these forest strips and for the establishment of tree belts along the stream and river banks. They stipulate the following minimum widths of reservations [12]:

- i. Rivers (or Streams) with a width of less than 4.6 m (15 ft.): 20 m (66 ft. / one chain) from the bank of each side.
- ii. Rivers with 4.6 – 15.2 m (15 -50 ft.) width: 40 m (two chains) from the bank of each side.
- iii. Rivers with a width of more than 15.2 m (50 ft.): 60 m (three chains) from the bank of each side.

According to the Agrarian Development Act, No. 46 of 2000 and the National Land Use Policy (Drafted in 2006) -iii – 7, the reservations of all natural and man - made water courses and sources whether private or state will be demarcated and protected through appropriate conservation measures [13].



Figure 1: Well managed stream reservations
Sources: Google images 2012, (Imagery date 05/07/2012)

The indirect ecosystem functions of these reservations are the conservation of biodiversity, supplying medicinal plants, fuel woods, wild fruits and carbon sequestration in the forests. Due to the land clearing, Agro-well constructions with machinery usages, collecting woody parts for agricultural necessities, the forest reservations as well as tank reservations has been damaged (Perera, 2016) [9].

This background has developed a platform to build the hypothesis for this study as “Agro-well development has damaged the stream reservations”.

2. Objectives

Accordingly, the overall objective of this study is to examine, whether the Agro-well development has affected the stream reservations in the Dry Zone of Sri Lanka.

The descriptive objectives are,

- i. To identify the Agro-well availability of stream reservations.
- ii. To examine the nature of the impacts.
- iii. Examine whether the impacts are significant.

3. Methodology

North Central Dry Zone of Sri Lanka was selected for this study due to the significance of Agro-well development. Further, all the mini basins in the central Dry Zone area have been converted to Tank cascades. Therefore, 20 sample tank cascades were randomly selected for the study. To obtain the information on Agro-wells construction in stream reservations of the study area, the Geo-Eye 1 satellite images (Geo Eye 1 - 2012 - 0.5m high resolution exclusive images) and Google images were observed. Then the field verifications with the assistance of key farmers, were completed for the final data base.

Secondly, basic data of the area and agro-well availability in stream reservations were confirmed with field studies and focus group discussions. In addition to that in-depth field observations and interviews of key farmers were also used for gathering necessary data. Twenty focus group discussions

were conducted for all 20 tank cascades and 10-12 outstanding farmers representing lower, middle and upper parts of the tank cascade, participated in the discussion.

To understand the legislative background as well as to examine the disturbances of environmental laws and regulations related to stream reservations, Land Development Ordinance No.19 of 1935, land regulations-15-10-1948 No 9912 and the Land Development Ordinance of 1970, Agrarian Development Act, No. 46 of 2000 and the National Land Use Policy (Drafted in 2006) were considered. Within the current study area, all the streams belong to the 1st category and accordingly, there should be 20 m width reservations. Geo-Eye 1 satellite images were used to prepare GIS maps for necessary analysis. In addition to that, map interpretations, density calculations, correlations, significant tests were used for the necessary analysis.

4. Results and Discussion

To get the idea on Agro-wells construction in stream reservations of the study area, at first the reservation buffer was identified, with reference to the regulations. All the streams in the study area belong to the category of “streams width of less than 4.6 m (15 ft). According to the Land Development Ordinance No.19 of 1935, land regulations -15-10-1948 No 9912 and the land development ordinance of 1970, there should be 20 m (66 ft./ one chain) reservation buffer of each side of the streams.

Secondly, a primary Google count of Agro-well availability in stream reservations (within 20 m buffer zone) of 20 tank cascades was obtained. Then, the field verifications with the assistance of farmers were completed.

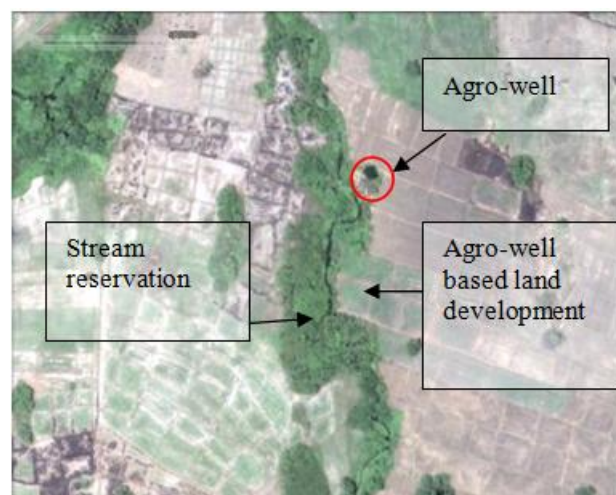
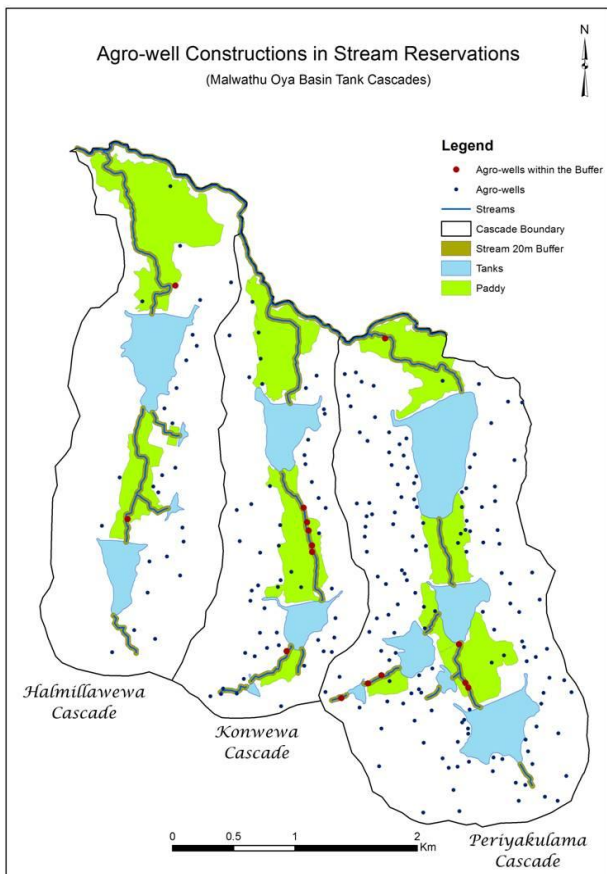


Figure 2: An Agro-well in a stream reservation
Sources: Google images 2012, (Imagery date 05/07/2012)

Area calculations were completed with GIS maps based on Geo Eye 1 satellite images. Finally, an Agro-well availability data base both referring to tank cascade level as well as stream reservation level, could be made. Further GIS maps were produced to identify the Agro-wells in reservations through a map.

Map 1: Agro-well availability within the 20 m stream reservation buffer.



Source: Geo Eye 1 satellite images, 2012

Different numbers of Agro-wells in stream reservations were recorded in 20 tank cascades. The lengths of the stream reservations were also different. Therefore, the number of Agro-wells per km for each cascade was computed. Results showed that the Agro-well availability in stream reservations varied from 0 to 3.3 Agro-wells per km.

Then Agro-well availability in stream reservations and Agro-well density of cascades were correlated. The results have shown that, with the increase of Agro-well density in tank cascades, Agro-well constructions in stream reservations also increased. With the increase of Agro-well density, more than 13.5 per sq.km in a cascade, Agro-well constructions in stream reservations have been increased more than 2 per km. That situation was revealed in 50% of tank cascades. When the Agro-well density is 22 per sq.km, Agro-well constructions in stream reservations has been increased up to 3.3 per km. This positive correlation has clearly shown that Agro-well development has increased the construction of Agro-wells in stream reservations.

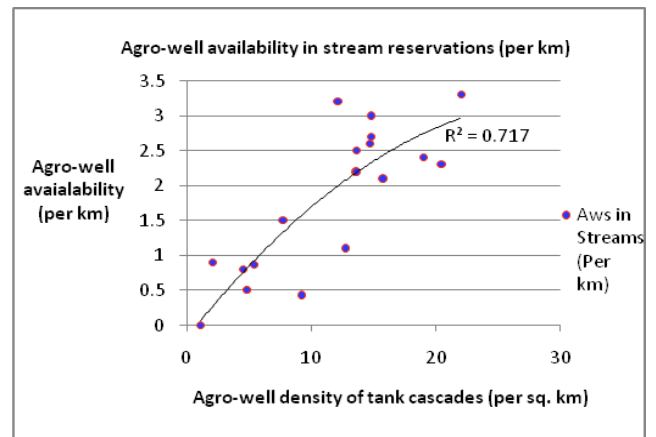


Figure 3: Relationship between the Agro-well densities with Agro-well availability in stream reservations
 Source: Geo Eye 1 satellite images, 2012 and GIS calculations

About 41% of Agro-wells in the stream reservations have removed the forest patches to construct the wells. Rest of the wells (59%) has been constructed in an open land but within the reservation area (within the 20 m buffer zone). Agro-well based agricultural land area development has occurred in 23% of Agro-wells in the reservation, while 77% lands have been developed outside the reservation. In addition to that, physical damages to the reservations due to machinery usages, extraction of the poles and other woody parts from the reservations for the requirements of the Agro-well based agricultural activities were also recorded. However, re-establishing the tree belt within the stream reservation may be problematic due to the Agro-well availability. Then it was compared to the Agro-well availability in stream reservations between high Agro-well density cascades and low Agro-well density cascades. Therefore, the 5 highest Agro-well density cascades and the 5 lowest Agro-well density cascades were separated to compare the status of the Agro-well availability in stream reservations.

Table 1: The highest Agro-well density cascades and Agro-well availability in stream reservations

No	Tank cascade	Agro-well density	Agro-wells in stream reservations (Aw/per km)
1	Periyakulama	22.0	3.3
2	Galwaduwegama	20.4	2.3
3	Belikulama	19.0	2.4
4	Kudagalenbindunuwewa	15.7	2.1
5	Konwewa	14.8	3

Source: Field study 2014

Table 2: The lowest Agro-well density cascades and Agro-well availability in stream reservations

No.	Tank cascade	Agro-well density	Agro-wells in stream reservations (Aw/per km)
1	Rambewewa	1.1	0.0
2	Halmillawewa	2.1	0.9
3	Kawarakulama	4.5	0.8
5	Dambagahaulpotha	4.8	0.5
4	Kowankulama	4.8	0.5

Source: Field study 2014

According to the Agro-well availability data there were more than 2 Agro-wells per sq.km of streams in high Agro-well density cascades and less than 1 Agro-well per sq.km recorded in the lowest Agro-well density cascades.

However, a significant test was conducted to examine whether these differences of Agro-well availability in stream reservations were significant or not.

Table 3: Difference means T – Test for Agro-well availability in stream Reservations

	Highest Aw density cascades	Lowest Aw density cascades
Mean	2.620	0.540
SD	0.507	0.351
N	5	5

P value and statistical significance:

The two-tailed P value equals 0.0044

By conventional criteria, this difference is considered to be very statistically significant.

According to the T test, comparatively Agro-well availability in stream reservations has been very significant.

5. Conclusion

It was revealed that although there were relevant regulations to protect the stream reservations, Agro-wells have been constructed in these reservations. An Agro-well availability in stream reservations has been recorded up to 3.3 Agro-wells per km. With the increase of Agro-well density in tank cascades, the number of Agro-wells in stream reservations has been increased. Different kind of impacts to the reservations such as removal of the forest patches to construct the wells, expansion of the agricultural area towards the reservation, physical damages, and collection of woody parts were also identified. There was a positive correlation between Agro-well constructions in stream reservations and the increase of Agro-well density of tank cascades. Agro-well availability in stream reservations is significant (P value = 0.0044) when compared to the high Agro-well density cascades and low Agro-well density cascades.

Accordingly, “Agro-well development has damaged the stream reservations”, could be accepted as the hypothesis for this test. Therefore, it is clear that the Agro-well development has damaged the stream reservations in the Dry Zone of Sri Lanka.

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Author Profile



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