Development of Agro-well Lands and Its impact on Soil Salinity in the North Central Dry Zone of Sri Lanka

Muditha Prasannajith Perera

Department of Geography, University of Peradeniya, Sri Lanka
Mudithpp[at]pdn.ac.lk, mudithpras[at]gmail.com

Abstract: ***Agro-well development in the Dry Zone of Sri Lanka has been accelerated recently. Accordingly a significant land proportion has been converted to Agro-well based lands. This matter has been attracting the attention of policy makers as well as researchers because the understanding of the real situation has been a national level requirement. Therefore the current study was launched in the North Central part of the Dry Zone of Sri Lanka during the period of 2014-2015. It was a comparative assessment of the salinity levels of the Agro-well lands and rain-fed lands. Further, the soil salinity data was correlated with the cropping duration of the Agro-well lands. The first part of this study has revealed that the soil salinity levels of Agro-well lands were in the 'very low category' (< 0.15 dS/m). Comparatively, salinity status has been developed in 66% of Agro-well lands, than of rain-fed lands. However, it has been revealed that soil salinity has increased with the increase of cropping duration in Agro-well lands. Accordingly, after the next 25 years E/C values can be increased up to 'medium salinity level' (up to 0.4 dS/m).***

Keywords: Agro-wells, Mini basins, Watering, Soil salinity

1. Introduction

With the inadequacy of surface water resources for agricultural activities, shallow groundwater recourses in low-lying valleys, alluvial deposits and in the vicinity of small tank systems and tributaries have been approached for excavating Agro-wells in the Dry Zone of Sri Lanka. This art of agriculture emerged in 1980s especially in the central part of the dry zone known as "Agro-well farming" and it is now spreading with the blessing of development agencies and the over enthusiasm of farmers (Dharmasena, 2000) [3].

Figure 1: Groundwater for agriculture

Figure 2: Agro-well lands & Rain-fed lands
Source: Google images, Imagery date 5/7/2012

Further, Agro-wells have gained popularity as the farmer has flexibility in the selection of crops and period of cultivation, as well as the irrigation water independency, in addition to the economic profitability. Generally, ground water has emerged as the primary democratic water source and the poverty reduction tool in many rural areas. Therefore, a number of recent agricultural planers, especially in the dry zone of Sri Lanka, focused on ground water utilization and agricultural development. (Kikuchi *et. al* 2003) [4].

According to Dharmasena and Goodwill's recommendation (1999) [2], if at least a water column of 2 m is found by the end of the dry season, such locations can be considered suitable for the construction of Agro-wells. Farmers who have understood this background, together with governmental and nongovernmental officers, started to use this resource. Further, a majority of the farmers did not hesitate to excavate in their low lands, with or without governmental support. Thus, a number of minor and major irrigation schemes as well as a large extent of low lands in small inland valleys, in the dry zone of Sri Lanka were converted in to the "Agro-well lands" [9]. Consequently the number of Agro-wells has been increased approximately up to 120,000[11].

Figure 3: Well developed Agro-well lands

The construction and development of Agro-wells was not determined solely by hydrological considerations as commonly envisioned. There were other political, economic and management factors that play a role in driving this new development over the last few decades (Panabokke *et al.* 2002) [7]. The average diameter of Agro-wells in the North Central Dry Zone is 4-7 m and average depth was 4-9 m. The current study has shown that the average ground water level fluctuates between 3-7.5 m in the dry months (July – September). Further about 90% of Agro-wells have at least 2.0 m water depth in the most dry months (July – September) in the area. The Agro-well based agricultural lands in the area were a large range of land as 0.2 ha to 1.4 ha. Most probably farmers are changing the annual crop land and cultivate under the Agro-well water within the entire land belonging to them.

Normally Agro-well land receives 20 to 40 times of irrigation watering from the Agro-wells for a season. (Perera, 2010) [10]. All the received water to the land becomes evapo-transpiration and infiltration to the ground, leaving sodium parts in the top soil. Continuing this process annually, may cause build-up of salinity in soil.

Figure 4: watering for Agro-well lands

A particular water quality study at Paranahalmilla wewa cascade, conducted by Yatigammana (2010) [13] revealed that, "most of environmental variables show a marked spatial variation along the cascade. Most importantly evapo-concentration of ions was noted along the downstream direction and terminal tanks in the cascades show the highest salinity and specific conductance values".

The surface water quality of Malwathu Oya cascade-I was better in wet flow compared to dry flow and the water quality was still good enough for irrigation even in dry flow in upper and middle parts of the cascade. But the lower area of the cascade showed slight to moderate salinity condition during dry flow (Perera *et al.*, 2011) [8]. However, Yatigammana (2010) [13] and Marambe *et al.* (2012) [6] revealed that encroachment of the *kattakaduwa* area in village tank ecosystems for cultivation may lead to a build-up of soil salinity and iron toxicity in crop areas.

Kumari *et al.* (2013) [5] have conducted a water quality test including the electrical conductivity (E/C) tests in selected cascades in the Anuradhapura district. According to the Wilcox (1955) [12] Classification, the E/C values have been showed that 35%, 55% and 10% of the Agro-wells had good, doubtful and unsuitable quality of irrigation water, respectively. These changes may affect to the soil.

Therefore, a comparative study between Agro–well lands and non Agro-well lands (rain-fed lands) was planned, to identify the salinity impact of Agro-well lands. The aim of this study was to examine whether the Agro-well based agriculture causes soil salinity due to water pumping on the land for a few years.

Figure 5: Rain-fed lands in the dry zone

2. Methodology

The method was testing Electrical Conductivity (E/C) values in soil samples covering 42 sample lands in 6 tank cascades in Malwathu Oya basin and Yan Oya Basin in the North Central Dry Zone of Sri Lanka.

A comparative study between the Agro-well lands and non Agro-well (rain-fed) lands was conducted as the first step. Three tank cascades in Malwathu Oya basin in the North Central Dry Zone were selected for this study (Map 1). These cascades are very similar in rainfall, geomorphologic and land use factors except the Agro-well density. 18 sample lands were randomly selected to represent Agro-well lands and non-Agro-well lands, covering upper - middle and lower areas of each cascade. Samples were collected two times covering dry and wet period (July & November). The electrical conductivity tests were conducted under the laboratory condition using saturated paste (1:5- Suspension) method.

Electrical conductivity level interpretation of this method was as follows.

Table 1: Interpretation of 1:5- Suspension Method

Category	E/C (1:5) dS/m
Very high	> 2.0
High	0.8 - 2.0
Medium	0.4 - 0.8
Low	0.15-0.4
Very low	< 0.15

Source: Dharmakeerthi (2007) [1]

Relevant to the above interpretation, the classification of salinity suitability for the agricultural activities was identified according to the recommendation of Wilcox (1955) [12] as follows.

1) Excellent (0.01-0.25 dS/m)
2) Good (0.25-0.75 dS/m)
3) Doubtful (0.75-2.25 dS/m)
4) Unsuitable (>2.25 dS/m)

Accordingly, the statuses of the salinity levels of soils in the study area were identified.

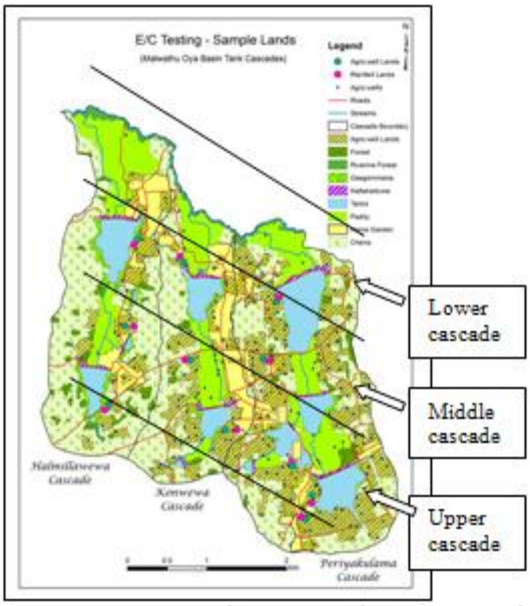

Figure 6: Sample lands for electrical conductivity testing
Source: Geo Eye 1 satellite images, 2012

Figure 7: Soil samples
Source: Laboratory testing, 2014

Figure 8: E/C testing
Source: Laboratory testing, 2014

Secondly, salinity trends were identified by forecasting the data. To identify the accurate long term salinity impact of Agro-well based lands 24 soil samples were collected covering lower, middle and upper areas of 6 tank cascades, in Malwathu Oya basin and Yan Oya basin of the North Central Dry Zone. All sample lands have 7 to 25 years of cultivation period.

3. Results and Discussion

3.1 A comparison between Agro-well lands and rain-fed lands

The electrical conductivity values of all Agro-well lands were 0.03 dS/m -0.07 dS/m. The rain-fed lands were between 0.03-0.08 dS/m. However, all the samples were under the very low category (<0.15 dS/m) and 66% of Agro-well lands have been recorded to have a comparatively high value than the nearest rain-fed lands.

It was revealed that the average E/C value of Agro-well lands was 0.0611 dS/m and average E/C value of rain fed lands was 0.0511 dS/m . Accordingly, 0.01 dS/m difference could be identified between the two land categories. Therefore, a significant test was conducted using the "Graph pad software", to check whether the difference was significant or not.

Table 2: Difference means T – Test for E/C values

	Agro-well lands	Rain-fed lands
Mean	0.0611	0.0511
SD	0.0154	0.0162
N	9	9

P -value and statistical significance:
The two-tailed P value equals 0.1950
By conventional criteria; this difference was considered to be not statistically significant.

Accordingly, the first part of this study has been revealed that the salinity levels of the Agro-well lands were in "very low category". Average salinity level of the Agro-well lands was high from 0.01 dS/m than from rain-fed lands. But it was not a significant difference.

3.2 Long term trend of the salinity levels of Agro-well lands

The data was analyzed following the same way as the above part. 30% of the samples were recorded more than 0.08 dS/m, while one sample recorded as 0.15 dS/m E/C value. Rest of the samples were less than 0.08 dS/m.

The electrical conductivity values of the relevant Agro-well lands correlated with the cropping duration of each land (Graph 1). Results have shown an increasing trend of salinity levels with the increasing of the cropping duration. The early period of Agro-well lands have been recorded around 0.04 dS/m of E/C levels. After 10 years of cropping period E/C value became more than 0.06 dS/m except in one sample. Further, after 17 years of cropping period all the samples have been shown more than 0.07 dS/m of E/C levels, while one of the lands (25 year cropping land) showing 0.15 dS/m of E/C level.

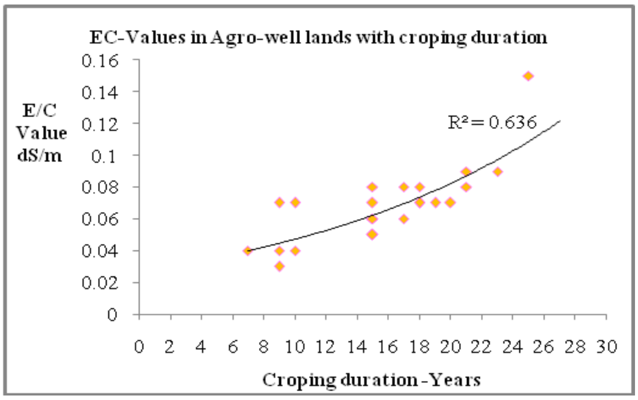

Figure 9: Correlation of E/C values and cropping duration of Agro-well lands (Source: Field data, 2013)

Accordingly, it has been proven that soil salinity has increased with the increase of cropping duration. However 96% of lands were in the "very low soil salinity" category yet, while 4% was in the margin of "very low" to "low" salinity status.

However, the significant point was the revelation of a long term increasing trend of salinity level in these lands, when forecasting the same data.

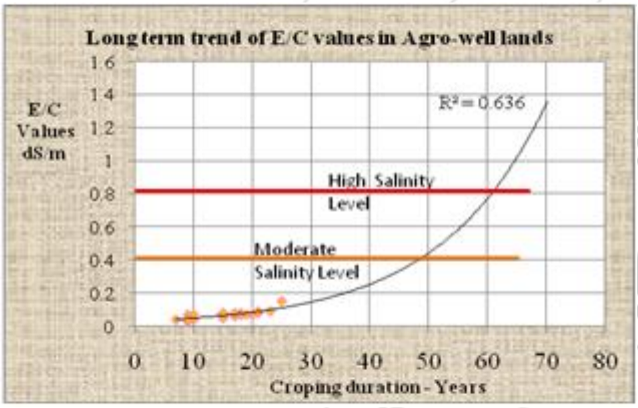

Figure 10: Forecasting of the long term salinity trend. (Source: Field data, 2013)

According to the current trend of increasing the salinity, it was revealed that, when the cropping period was about 48 years, salinity level may increase up to a "moderate level". Further when cropping period was about 60 years salinity level may be at a "high level". Average maximum cropping period of the area was 23years up today. Accordingly, if the current condition continues and if the management strategies are not implemented in due course, after the next 25 years the salinity status may reach up to the "medium salinity" level (0.4 - 0.8 dS/m). Further, the increasing of soil salinity may be a serious hazard in Agro-well lands within the next 40 years. According to the recommendation of Wilcox (1955) [12], with the increase of the E/C level for more than 0.75 dS/m (after next 40 years), the agricultural suitability of these lands may be "doubtful".

4. Conclusion

The first part of this study has revealed that the soil salinity levels of Agro-well lands were in the "very low category". Comparatively salinity status has been developed in 66% of Agro-well lands, than the nearest rain-fed lands. According to the significant test, average salinity levels of Agro-well lands and rain-fed lands have shown no significant difference, yet.

However, it has been revealed that soil salinity has increased with the increase of cropping duration of Agro-wells. According to the analysis of the long term salinity trends in Agro-well lands, after the next 25 years E/C values can be increased up to "medium salinity " level (up to 0.4 dS/m) and after the next 40 years E/C values can be increased up to "high salinity " level (more than 0.8 dS/m) under the current condition. These results signal that, the soil salinity will be a problem, in Agro-well lands in the North Central Dry Zone of Sri Lanka in the near future.

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Author Profile

Muditha Prasannajith Perera is a Senior Lecturer at the Department of Geography, University of Peradeniya, Sri Lanka. He has 12 years of teaching experience and research experience. He has published a number of Magazine Articles, Journal Articles and Books. He is engaging in Watershed Management studies, Sri Lankan Hydraulic Civilization based studies and Tank Cascade studies. Currently he is pursuing his PhD in the field of tank cascade studies.