

**SPATIO-TEMPORAL VARIABILITY OF THE QUALITY OF THE
IRRIGATION WATER IN A RICE-OTHER FIELD CROPS
CROPPING SYSTEM IN THE MAHAWELI SYSTEM 'H' OF
SRI LANKA**

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ABSTRACT

A better understanding of the spatial and temporal variation of the quality of irrigation and shallow ground water and its impacts on soils are very important in formulating proper soil management strategies to minimize its impact on crop productivity. A study was conducted to assess the spatio-temporal variability of water quality in the irrigation, the drainage and the shallow ground water in rice-other field crops cropping system in the Mahaweli system 'H' area in the Dry zone of Sri Lanka. This study was conducted in two sites at Thalawa and Galnewa situated in the Mahaweli system 'H' with the water supply from the Kalawewa reservoir. Water samples were obtained during January to March and June to September 2014 representing the 2013/14 *Maha* and the 2014 *Yala* seasons. Perforated PVC pipes were installed to collect the shallow ground water in different elevation classes along the slope of the rice fields. Water samples were collected from the field channels, the drainage channels and the perforated PVC pipes during the research period. The Electrical Conductivity (E_{c_w}), the pH and the concentrations of Na, Ca, Mg, K of the water samples were measured using standard laboratory procedures. The Sodium Absorption Ratios (SAR) were calculated. The levels of E_{c_w} , pH, Na, Ca and SAR of the irrigation water, the drainage water and the shallow ground water in the selected investigation sites in Thalawa and Galnewa areas of the Mahaweli system 'H' area are within the usual range specified under the FAO standards for irrigation. Comparatively higher concentrations of Mg and K are found throughout both cropping seasons. Further, the Mg and the Na contents are at comparatively higher levels in the shallow ground water in the lower positions of the landscape and in the drainage water indicating the lateral and the vertical leaching of those ions from the soil to the water. Comparatively higher levels of pH as well as the concentrations of Ca and K are found in the field irrigation water in both cropping seasons.

Key words: Irrigation water quality, Spatio-temporal variability, E_{c_w} , Ph, SAR

INTRODUCTION

The Mahaweli irrigation scheme is one of the major irrigation systems in Sri Lanka under which, the rice - other field crops (OFC) cropping system is commonly practiced in the Dry zone. Other field crops such as chilli, maize, big onion and legumes are cultivated in a considerable land extent under supplementary irrigation in paddy lands in *Yala* season whereas; rice is cultivated in both *Yala* and *Maha* seasons.

Quality of irrigation water refers to its physical, chemical and biological characteristics that will influence its suitability for the crop production. Thus, availability of good quality water is a key factor determining crop productivity in drier regions. In evaluation of irrigation water, the emphasis is often placed on the chemical and physical characteristics (FAO, 1985; FAO, 1998). Threshold limits of these characteristics are used to formulate guidelines determining the suitability of irrigation water. However, none of guidelines can be directly used owing to wide variability in soil conditions (FAO, 1985). Often, soil conditions namely, salinity, sodicity, acidity, water infiltration rate and toxicity of ions are considered when preparing site-specific evaluation of the quality of irrigation water (FAO, 1985; Gunawardhana, 2009).

Soil salinity becomes a problem when soluble salt concentration in the crop root zone reaches to a level that causes a loss in yield. In irrigated areas, these salts are often originated from salts in the applied water or shallow ground water. Bandara (1998) reported the importance of local-scale hydrological studies addressing the inland salinity caused by improper management of soil drainage, salinity intrusion of surface water and ground water and drainage problems in agriculture. Soil pH is an important soil property that determines many other soil chemical and biological properties (FAO, 1985). Use of irrigation water with a pH outside the normal range (6.0 - 8.4) can cause changes in soil leading to nutritional imbalances or toxicities of ions (FAO, 1985; FAO, 1998). Soil structure and its stability are physical characteristics affecting the soil water retention and movements. Relatively high sodium or low calcium content of irrigation water causes poor soil

structure resulting in a reduced infiltration and water retention within the soil. Thus, both electrical conductivity (EC_w) and the sodium absorption ratio (SAR) of the applied water are considered as key water quality parameters (FAO, 1985; Suarez *et al.*, 2006). Toxicity of ions is caused by their accumulation in the rhizosphere at high concentrations. It has been reported an increased effect of Na on crop productivity when irrigation water with high Mg contents ($Ca/Mg < 1$) was used (FAO, 1985).

In irrigated agriculture, development of soil salinity is also associated with the input of soluble salts from shallow ground water. Thus, monitoring the quality of shallow ground water and its variability is essential to salinity control and to successful long-term irrigated agriculture (FAO, 1985).

A better understanding of the spatial and temporal variation of the quality of irrigation and shallow ground water and its impacts on soils are very important in formulating proper soil management strategies to minimize its impact on crop productivity (FAO, 1985; Gunawardhana, 2009). This study was conducted to assess the spatio-temporal variability of water quality in rice-other field crops cropping system in the Mahaweli System 'H' major irrigation scheme in the Dry zone of Sri Lanka.

MATERIALS AND METHODS

Site selection

This study was conducted in two sites in Thalawa ($8^{\circ} 14' 12.87''$ N, $80^{\circ} 17' 41.50''$ E) and Galnewa ($8^{\circ} 00' 39.19''$ N, $80^{\circ} 29' 54.31''$ E) areas (Figure 1). Both sites are situated in the Mahaweli 'H' zone and with the water supply from the Kalawewa reservoir (Figure 2).

The study sites belong to the DL_{1b} agro-ecological region where rice-OFCs cropping system has been practiced for about thirty years period. The dominant great soil group is Low Humic Gley (Typic Endoaqualf) (Mapa *et al.*, 2010).

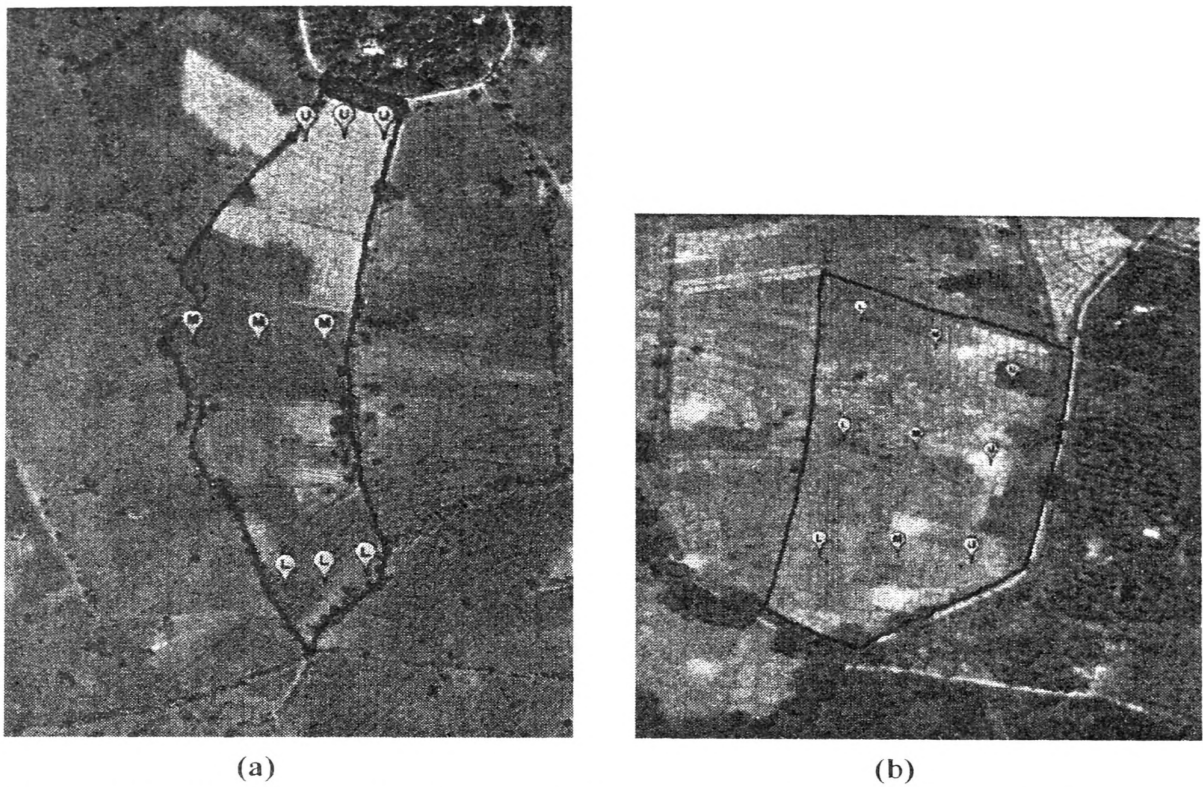


Figure 1. Satellite images showing (a) Thalawa and (b) Galnewa sites including the points with the perforated PVC pipes

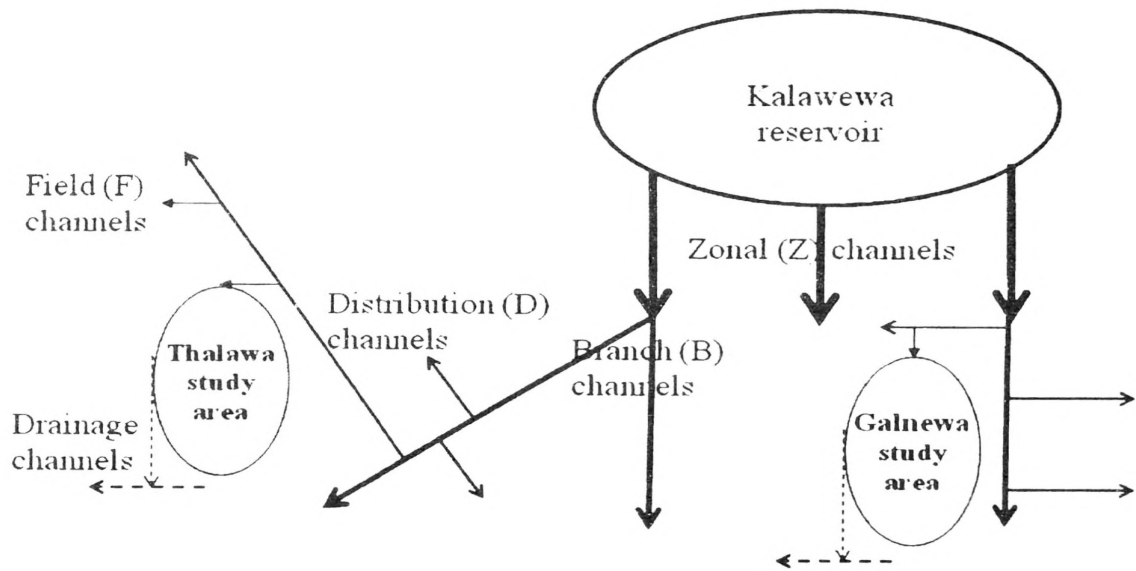


Figure 2. Schematic diagram of the main irrigation distribution system in the Mahaweli 'H' zone and the study areas

Collection of the water samples

The water samples were obtained during January to March and June to September 2014 representing the 2013/ 14 *Maha* and the 2014 *Yala* seasons. Three positions in the landscape (i.e. upper, middle and lower) were identified along the slope within each site. Three perforated PVC pipes were installed up to 2 m depth in each position in each site. These perforated PVC pipes were used to collect the shallow ground water in different elevation classes along the slope of the rice fields (Figure 1). Two water samples were collected from each field channel (commonly known as F channel) and from each field drainage channel at each irrigation event during the research period. Simultaneously, a water sample was collected from each perforated PVC pipe in each study site for laboratory analysis.

Laboratory analysis

The water quality parameters, Na and K contents were analysed using the flame photometer (PG instruments, UK). The atomic absorption spectrophotometer (Varian, Australia) was used to measure the Ca and the Mg contents. The multi parameter analyzer (Hatch, USA) was used to measure the electrical conductivity (EC_w) and the pH. The data were analyzed to explore temporal patterns of the quality of irrigation, drainage and shallow ground water of the selected sites.

The sodium absorption ratio (SAR) was calculated using the following equation (Equation 1).

$$SAR = \frac{Na}{\sqrt{\frac{Ca+Mg}{2}}} \dots\dots\dots (1)$$

where, Na denotes Sodium in mEq/ l, Ca denotes Calcium in mEq/ l and Mg denotes Magnesium in mEq/ l (FAO, 1985).

The data were analyzed using ANOVA statistical analytical procedure for irrigation - drainage water and shallow ground water separately. The means were compared using Duncan mean separation technique.

RESULTS AND DISCUSSION

Water quality in the irrigation and the drainage channels

The Table 1 shows the water quality parameters in the irrigation and the drainage channels. The mean EC_w , Na, Mg and SAR levels of the drainage water in Thalawa study site were significantly higher compared to those of the irrigation water in both 2013/14 *Maha* and 2014 *Yala* seasons (Table 1). The mean pH and Ca levels of the irrigation water were significantly higher compared to those of the drainage water in the 2013/ 14 *Maha* season whereas, those of both irrigation and drainage water did not show significant differences in the 2014 *Yala* season (Table 1). In Galnewa study area, the mean EC_w and Mg levels of the drainage water were significantly higher compared to those of the irrigation water whereas, the mean pH and Ca levels of the irrigation water were significantly higher in both 2013/ 14 *Maha* and 2014 *Yala* seasons (Table 1). The mean Na and SAR levels of the drainage water were significantly higher compared to those of the irrigation water in the 2014 *Yala* season (Table 1). The drainage water showed higher concentrations of Na and Mg compared to the irrigation water in both Thalawa and Galnewa sites in both 2013/ 14 *Maha* and 2014 *Yala* seasons indicating the leaching of Na and Mg from the soil towards the drainage water in the system. The mean K concentrations of the irrigation and the drainage water were not significantly different in Thalawa site in the 2013/ 14 *Maha* season and in Galnewa site in both 2013/ 14 *Maha* and 2014 *Yala* seasons whereas, a significantly lower K content was recorded in the drainage channel in Thalawa site in the 2014 *Yala* season (Table 1).

Water quality in the shallow ground water

The Table 2 shows the water quality parameters in shallow ground water. The mean EC_w , pH, Na, Ca, Mg and SAR levels of the shallow ground water (water in the perforated PVC pipes) installed in the in the lower position of the landscape were significantly higher compared to the upper position of the landscape in Thalawa study area in both 2013/ 14 *Maha* and 2014 *Yala* seasons (Table 2). Moreover, the same trend was found in Galnewa study area in the 2014 *Yala* season with an exception in the Mg concentrations (Table 2). The shallow ground water in the lower position of the landscape showed

higher concentrations of Na and Mg compared to that of the upper landscape in both Thalawa and Galnewa sites in both 2013/ 14 *Maha* and 2014 *Yala* seasons indicating the lateral leaching of Na and Mg from the upper position towards the lower position in the landscape. The K concentration of the shallow ground water in all the positions in the slope in Galnewa site in both 2013/ 14 *Maha* and 2014 *Yala* seasons and in Thalawa site in the 2013/ 14 *Maha* season were not significantly different whereas, a significantly lower K content was recorded in the lower position in Thalawa site in the 2014 *Yala* season (Table 2).

Table 1. The mean EC_w, pH, Na, Ca, Mg, K and SAR contents in the field channels and the drainage channels in Thalawa (n = 8 - 14) and Galnewa (n = 8 - 12) study areas in the 2013/ 14 *Maha* and the 2014 *Yala* seasons

Parameter	Source	Thalawa		Galnewa	
		2013/ 14 <i>Maha</i>	2014 <i>Yala</i>	2013/ 14 <i>Maha</i>	2014 <i>Yala</i>
EC _w (dS/ m)	Field channel	0.31 b	0.26 b	0.33 b	0.28 b
	Drainage channel	0.53 a	0.57 a	0.60 a	0.66 a
pH	Field channel	8.1 a	7.9 a	8.1 a	7.9 a
	Drainage channel	7.6 b	7.8 a	7.7 b	7.5 b
Na (mg/ l)	Field channel	12.6 b	19.1 b	19.8 a	16.0 b
	Drainage channel	30.7 a	45.1 a	28.2 a	41.3 a
Ca (mg/ l)	Field channel	8.0 a	7.9 a	8.2 a	7.9 a
	Drainage channel	7.6 b	7.8 a	7.6 b	7.5 b
Mg (mg/ l)	Field channel	61.4 b	103.7 b	90.1 b	64.4 b
	Drainage channel	139.7 a	130.8 a	105.0 a	156.2 a
SAR	Field channel	0.3 b	0.4 b	0.4 a	0.5 b
	Drainage channel	0.5 a	0.8 a	0.6 a	0.8 a
K (mg/ l)	Field channel	6.6 a	4.2 a	5.7 a	5.1 a
	Drainage channel	6.4 a	2.9 b	4.7 a	3.9 a

Note: The means denoted by the same letter are not significantly different at $p = 0.05$.

Table 2. The mean EC_w, pH, Na, Ca, Mg, K and SAR contents in the shallow ground water in Thalawa (n = 12 - 21) and Galnewa (n = 12 - 18) study areas in the 2013/ 14 *Maha* and the 2014 *Yala* seasons

Parameter	PVC pipe	Thalawa		Galnewa	
		2013/ 14 <i>Maha</i>	2014 <i>Yala</i>	2013/ 14 <i>Maha</i>	2014 <i>Yala</i>
EC _w (dS/ m)	Upper	0.38 b	0.31 b	0.51 a	0.30 c
	Middle	0.40 b	0.34 b	0.62 a	0.72 b
	Lower	0.75 a	0.68 a	0.64 a	0.95 a
pH	Upper	6.9 b	7.2 b	7.1 b	7.3 b
	Middle	7.0 b	7.3 b	7.2 ab	7.5 a
	Lower	7.4 a	7.6 a	7.4 a	7.6 a
Na (mg/ l)	Upper	14.7 b	19.3 b	23.1 b	22.4 b
	Middle	16.7 b	23.4 b	49.4 a	29.7 b
	Lower	43.9 a	62.5 a	30.1 b	40.0 a
Ca (mg/ l)	Upper	6.9 c	7.2 b	7.2 a	7.3 b
	Middle	7.0 b	7.3 b	7.4 a	7.5 a
	Lower	7.7 a	7.5 a	7.4 a	7.4 ab
Mg (mg/ l)	Upper	69.6 b	91.7 b	121.3 b	143.5 a
	Middle	80.5 b	103.0 ab	150.6 ab	95.7 a
	Lower	100.1 a	111.9 a	177.9 a	101.9 a
SAR	Upper	0.4 b	0.5 b	0.5 b	0.4 c
	Middle	0.4 b	0.5 b	0.9 a	0.8 b
	Lower	0.9 a	1.3 a	0.5 b	1.2 a
K (mg/ l)	Upper	5.4 a	2.9 a	6.8 a	4.0 a
	Middle	5.4 a	2.8 a	4.9 a	3.7 a
	Lower	5.0 a	1.6 b	4.3 a	2.4 a

Note: The means denoted by the same letter are not significantly different at $p = 0.05$.

The Electrical Conductivity (EC_w) of water

The mean EC_w levels of the irrigation water in both Thalawa and Galnewa study areas in both 2013/ 14 *Maha* and 2014 *Yala* seasons were around 0.3 dS/ m (Table 1). The Food and Agriculture Organization (FAO) guidelines specify that there is no restriction on the use of irrigation water having an EC_w below 0.7 dS/ m (FAO, 1985). Therefore, there was no limitation in using the irrigation water with respect to the EC_w levels in both sites in both seasons. Kendaramaga (2000) also reported similar electrical conductivity value (0.2 dS/ m) in Yoda Ela, which is one of the main irrigation channels (Zonal channels) starting from Kalawewa reservoir. The mean EC_w levels of the shallow ground water in both the upper and the middle

positions in Thalawa site in both seasons and in the upper position in Galnewa site in both seasons were less than 0.7 dS/ m (Table 2). The mean EC_w levels of the shallow ground water indicated an enrichment of soluble salts in the shallow ground water from the upper positions towards the lower positions in the landscape in both sites in both seasons (Table 2). The mean EC_w level of the shallow ground water in the lower position in Thalawa in the 2013/ 14 *Maha* season was 0.75 dS/ m and that was 0.72 dS/ m in the middle position and 0.95 dS/ m in the lower position in Galnewa in the 2014 *Yala* season indicating some restrictions for the plant growth with respect to the EC_w . Previous investigations have shown higher EC_e levels of soil in the lower position compared to the upper position in the landscape in the same study site in Thalawa area (Perera *et al*, 2015) figuring out the positive correlation between the EC_w levels of the shallow ground water and the EC_e levels of soil.

Temporal variability of the Electrical Conductivity (EC_w) of water

Temporal variability of EC_w levels of irrigation and shallow ground water in both sites are shown in Figure 3a - d. The EC_w of the drainage water was in increasing trend with time compared to the irrigation water in Thalawa site in both 2013/ 14 *Maha* and 2014 *Yala* seasons and in Galnewa site in 2013/ 14 *Maha*. The EC_w of the irrigation water showed the lowest levels (0.2 to 0.4 dS/ m) compared to the shallow ground and the drainage water in both sites throughout the study period (Figure 3a - d).

The pH of water

The mean pH levels of the irrigation water in both Thalawa and Galnewa study areas in 2013/ 14 *Maha* and 2014 *Yala* seasons were 8.1 and 7.9, respectively (Table 1). These levels were within the recommended pH range of irrigation water (6.0 - 8.4) by the FAO (FAO, 1985). Kendaramaga (2000) reported a favourable range of pH (6.0 to 8.4) in Yoda Ela and most of the agro-wells in the Dry zone of Sri Lanka. Amarasiri (1973) also reported that the water in major irrigation systems in the Dry zone of Sri Lanka had pH values around 8.0. The mean pH levels of the drainage water in both sites in both seasons showed lower values compared to the irrigation water (Table 1). Increasing trends were observed in the mean pH levels of the shallow ground water from the upper position towards the lower position in the landscape in

both sites in both seasons (Table 2). The similar trends observed in the levels of Na and Mg of the shallow ground water (Table 2) can result in the particular increasing trends in the pH of the shallow ground water.

Temporal variability of the pH of water

Temporal variability of the pH of the irrigation and the shallow ground water in both sites are shown in the Figure 4a - d. The pH of the shallow ground water in the upper position of the landscape showed the lowest levels with minimum fluctuations compared to that of the irrigation, the drainage and the shallow ground water in the lower positions in both sites throughout the study period (Figure 4a - d).

The Na contents of water

The mean Na contents of the irrigation water in Thalawa study area in the 2013/ 14 *Maha* and the 2014 *Yala* seasons were 12.6 mg/ l and 19.1 mg/ l, respectively whereas, those were 19.8 mg/ l and 16.0 mg/ l in Galnewa study area in the respective seasons (Table 1). According to the FAO guidelines, the usual range of the Na content in the irrigated water lies between 0 to 900 mg/ l (FAO, 1985). Therefore, the mean Na contents of the irrigation water were within the usual range according to the FAO guidelines. Kendaragama (2000) reported that the mean Na contents of surface and agro-well water were 15.5 mg/ l and 221.5 mg/ l respectively, in Painedikulama and Ihala Puliyanckulama areas in Anuradhapura district. Amarasiri (1973) also reported that the mean Na content in the shallow well water in the Low Country Dry zone of Sri Lanka was 221.6 mg/ l. The mean Na contents of the drainage water in both sites in both seasons showed higher values compared to the irrigation water (Table 1). However, the mean Na contents of both drainage and shallow ground water were also within the usual range according to the FAO classifications. Further, an increasing trend of the mean Na contents in the shallow ground water was observed from the upper positions towards the lower positions in the landscape in both sites in both seasons except in Galnewa study area in the 2013/ 14 *Maha* season (Table 2).

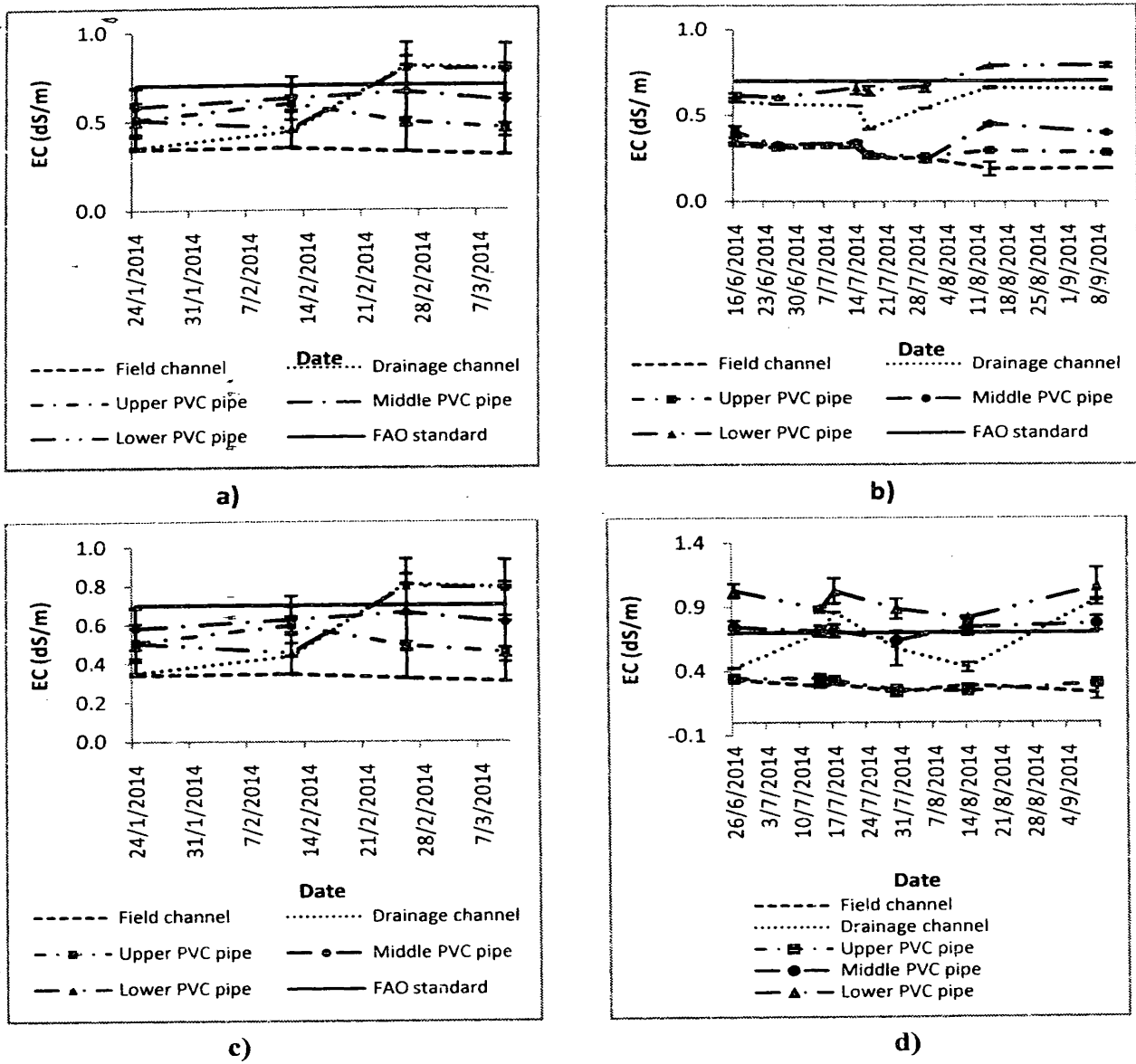


Figure 3. Temporal variability of the EC_w in the irrigation and the shallow ground water in Thalawa site during (a) 2013/ 14 Maha, (b) 2014 Yala and Galnawa site during (c) 2013/14 Maha, (d) 2014 Yala

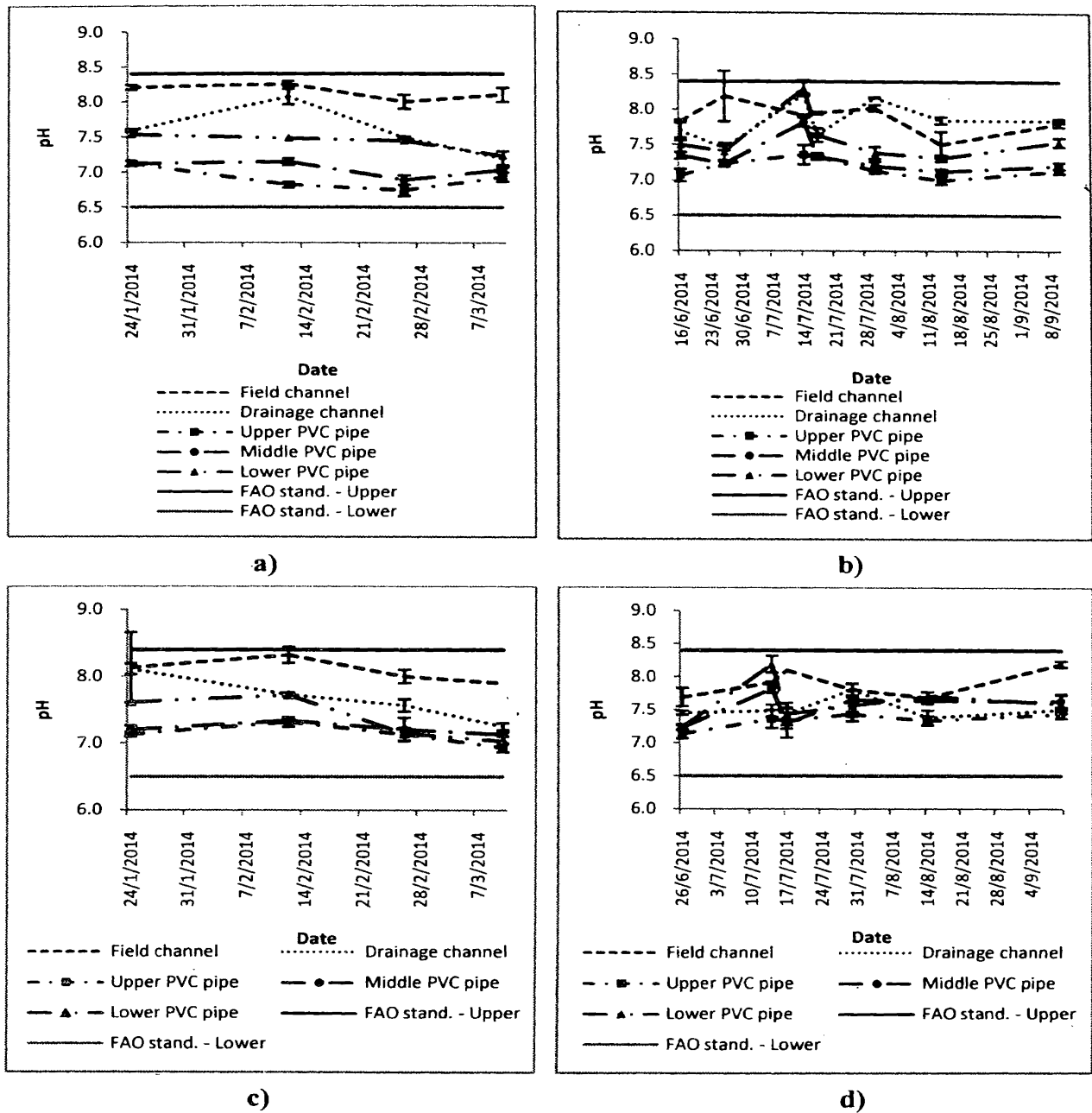


Figure 4. Temporal variability of the pH in the irrigation and the shallow ground water in Thalawa site during (a) 2013/ 14 Maha, (b) 2014 Yala and Galnewa site during (c) 2013/ 14 Maha, (d) 2014 Yala

Temporal variability of the Na contents of water

Temporal variability of the Na contents of the irrigation and the shallow ground water in both sites are shown in the Figure 5a - d. Comparatively higher Na contents were observed throughout the study period in the drainage and the shallow ground water in the lower positions except in Galnewa study area in the 2013/ 14 Maha season (Figure 5a - d). There were

increasing trends of the Na contents in all the water sources in both sites towards the end of the 2014 *Yala* season (Figure 5b and 5d).

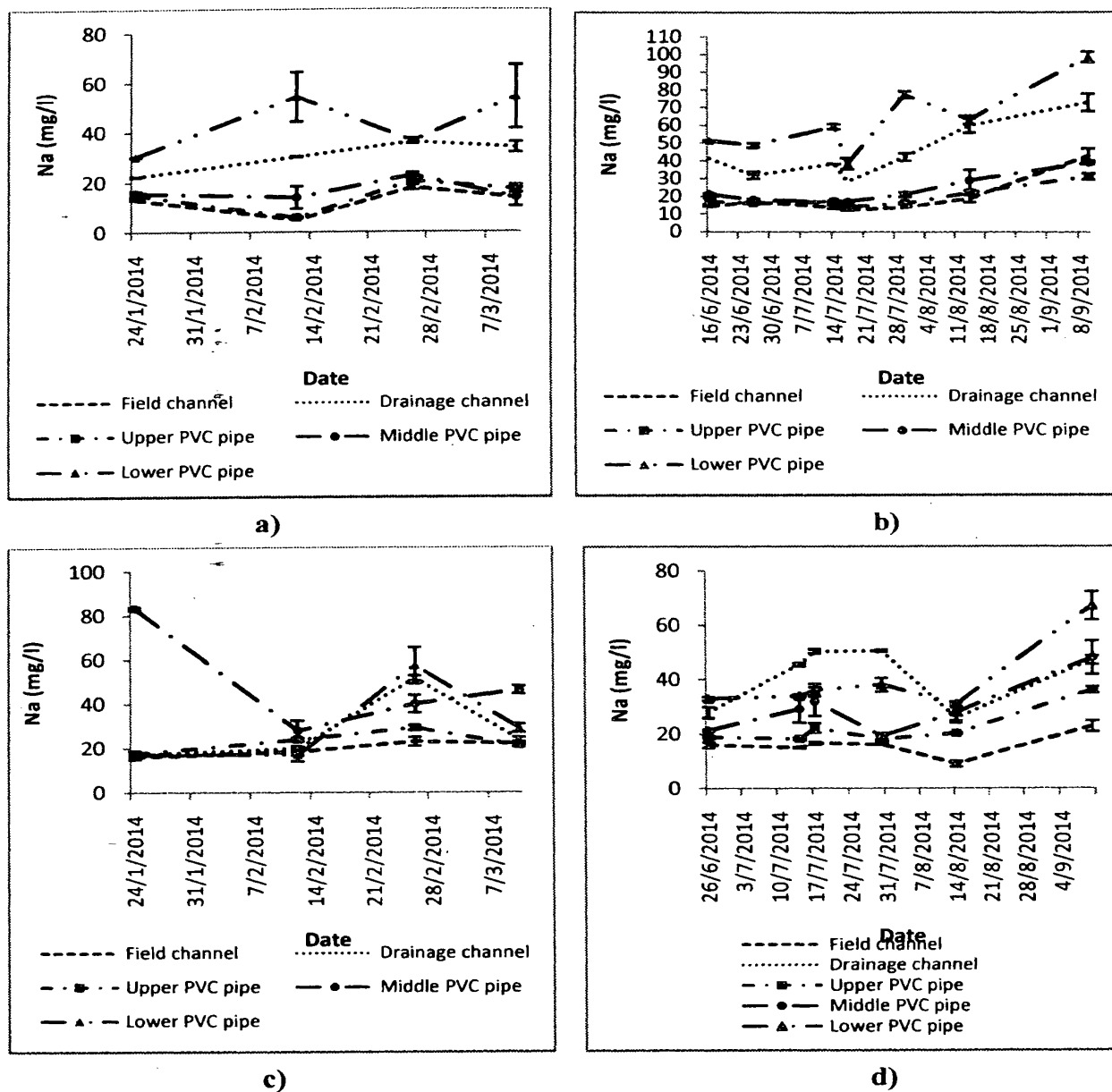


Figure 5. Temporal variability of the Na contents in the irrigation and the shallow ground water in Thalawa site during (a) 2013/ 14 *Maha*, (b) 2014 *Yala* and Galnewa site during (c) 2013/ 14 *Maha*, (d) 2014 *Yala*

The Ca contents of water

The mean Ca contents of the irrigation water in Thalawa study area in 2013/ 14 *Maha* and 2014 *Yala* seasons were 8.0 mg/ l and 7.9 mg/ l, respectively whereas, those were 8.2 mg/ l and 7.9 mg/ l in Galnewa study area in the respective seasons (Table 1). These values were within the usual level of the Ca content in irrigation water (0 - 400 mg/ l) reported by the FAO

(FAO, 1985). Kendaragama (2000) reported higher values of the Ca content in Yodha Ela (16.3 mg/ l) and similar values in Pindikulama and Ihala Puliyankulama tanks (8.3 mg/ l). The mean Ca contents of the drainage water were similar to irrigation water in both sites (Table 1). Moreover, increasing trends of the mean Ca contents in the shallow ground water was observed from the upper positions towards the lower positions in the landscapes in both sites in both seasons except in Galnewa study area in the 2014 *Yala* season (Table 2).

Temporal variability of the Ca contents of water

Temporal variability of the Ca contents of the irrigation and the shallow ground water in both sites are shown in Figure 6a - d. The Ca contents of the irrigation water were at higher levels (from 7.7 to 8.3 mg/ l) whereas, the Ca contents of the shallow ground water in the upper positions were at lower levels (from 6.7 to 7.5 mg/ l) in both sites throughout the study period. Temporal variability of the pH of the irrigation, the drainage and the shallow ground water (Figure 4a - d) showed similar trends in both sites throughout the study period clearly indicating the positive correlation between the Ca content and the pH of water.

The Mg contents of water

The FAO guidelines indicate that the usual range of the Mg content of irrigation water is 0 - 60 mg/ l (FAO, 1985). The mean Mg contents of the irrigation water in Thalawa and Galnewa study areas in both Maha and Yala seasons were above this range (Table 1). Amarasiri (1973) reported that the Mg content of Kalawewa reservoir was 17 mg/ l whereas; the mean Mg concentration of some of the selected shallow well water in the Low Country Dry zone was 99 mg/ l (Amarasiri, 2015).

The Kalawewa reservoir receives water from the upper Mahaweli catchment areas where Dolomite is frequently applied for crop cultivation, especially for tea and potato, as a soil amendment at higher rates. Long term application of Dolomite in the upper stream areas can lead to an enrichment of Mg in surface and ground water in the downstream areas such as the Mahaweli areas in the Dry zone of Sri Lanka.

The mean Mg contents of the drainage water in both sites in both seasons showed significantly larger values than irrigation water (Table 1). The mean Mg contents of the shallow ground water were larger than the usual level in irrigation water (Table 2). Except in Galnewa study area in the 2014 *Yala* season, increasing trends of the average Mg content was observed along the upper to the lower position in the landscape (Table 2). The Ca/ Mg ratio in the irrigation and the drainage water in both seasons were less than 1 indicating magnesium dominated irrigation and drainage water.

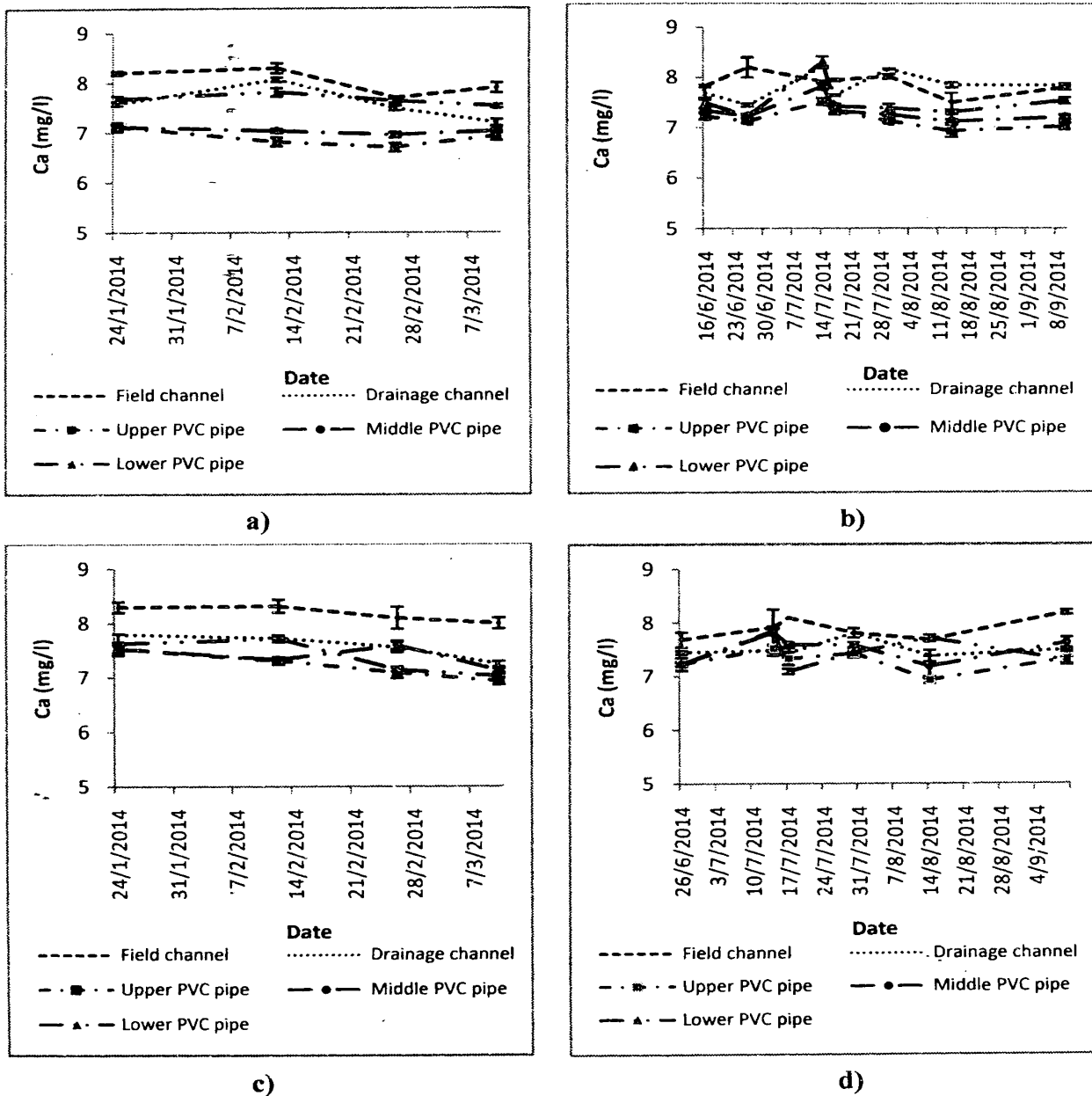


Figure 6. Temporal variability of the Ca contents in the irrigation and the shallow ground water in Thalawa site during (a) 2013/ 14 *Maha*, (b) 2014 *Yala* and Galnewa site during (c) 2013/ 14 *Maha*, (d) 2014 *Yala*

Temporal variability of the Mg contents of water

Temporal variability of the Mg contents of the irrigation and the shallow ground water in both sites are shown in Figure 7a - d. The drainage water consistently contained the highest Mg contents except in Galnewa site in the 2013/ 14 *Maha* season (Figure 7a - d). Unlike in the 2014 *Yala* season, the Mg contents of the irrigation water in both study areas in 2013/ 14 *Maha* season did not markedly change (Figure 7a - d).

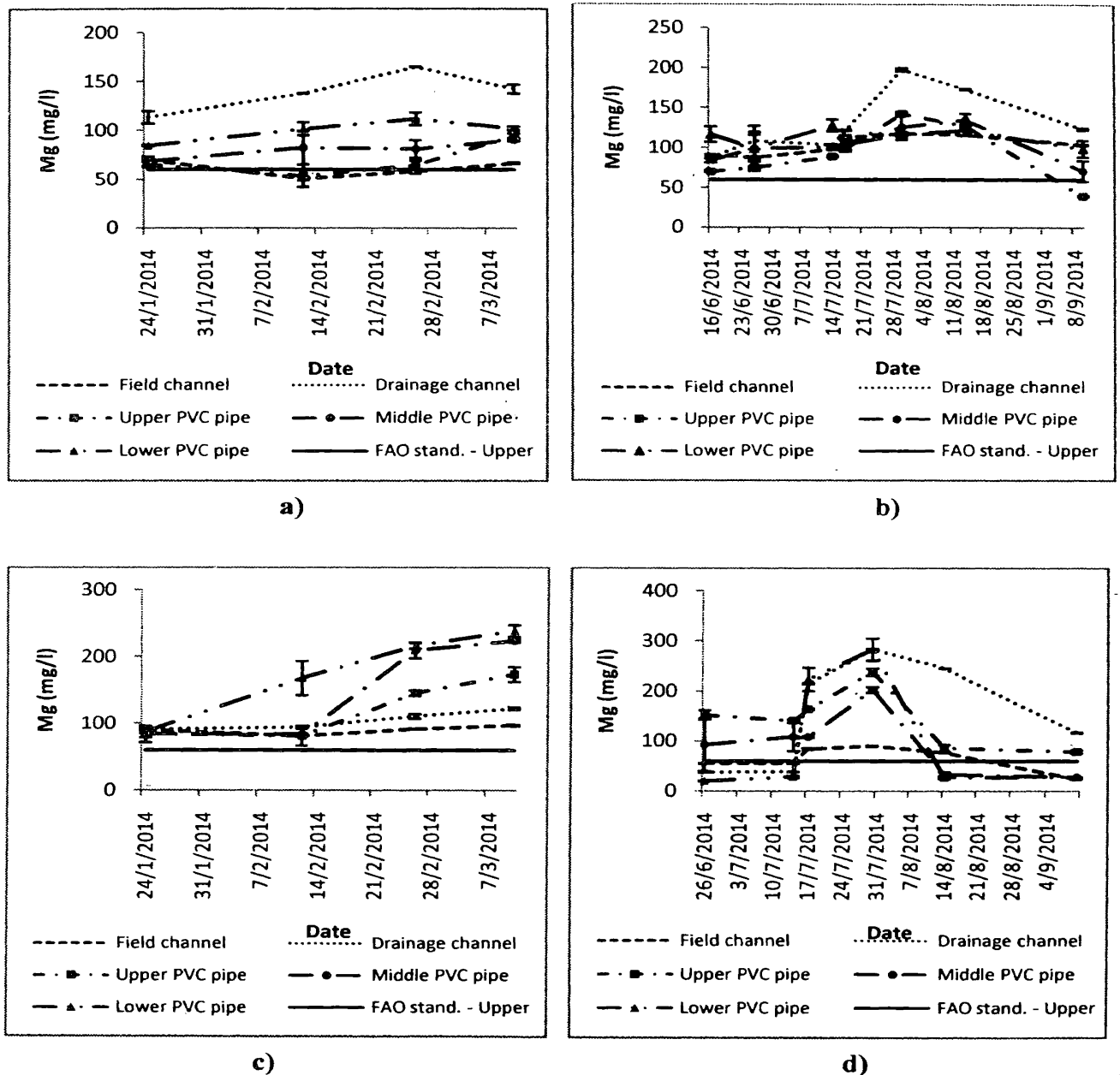


Figure 7. Temporal variability of the Mg contents in the irrigation and the shallow ground water in Thalawa site during (a) 2013/ 14 *Maha*, (b) 2014 *Yala* and Galnewa site during (c) 2013/ 14 *Maha*, (d) 2014 *Yala*

The Sodium Adsorption Ratios (SAR) of water

The Table 1 and the Table 2 show that the SAR levels of all the water sources were within the favourable range (FAO, 1985) given by the FAO (SAR = 0 - 3) in both study areas in both seasons. Therefore, there was no restriction in using the irrigation water with respect to the development of soil salinity. Kendaragama (2000) reported that the means of the SARs of water in Yoda Ela, Paindikulama tank and Ihala Puliyanikulama tank in Anuradhapura district were 0.3 to 2.5. Further, Gunawardhana (1995) reported lower values for the SARs of the surface water in the Mahaweli irrigation scheme.

Temporal variability of the SARs of water

Increasing trends of the SARs in the irrigation, the drainage and the shallow ground water were observed at the latter part of the 2014 *Yala* season in both sites (Figure 8b and 8d). Further, the similar trends were observed in the Na contents (Figure 5a - d) and the SAR of the water (Figure 8a - d) in both sites throughout the study period indicating a strong positive correlation between these two water quality parameters.

The effect of the SAR on the infiltration rate of water

The relationship between the SAR and the infiltration rate of irrigation water has been well established (Suarez *et al.*, 2006). When the SAR in irrigation water is below 3, the EC_w of that irrigation water should be > 0.7 dS/ m not to create any reduction in the infiltration rate and moreover, there may be slight to moderate reductions in the infiltration rate under the EC_w levels from 0.2 to 0.7 dS/ m in the irrigation water (FAO, 1985). Since the mean EC_w levels of the irrigation water were around 0.3 dS/ m, the negative effect of the SAR on infiltration rate was slight to moderate in both sites during the investigation period.

The K contents of water

The K contents in the irrigation and the shallow ground water in both Thalawa and Galnewa sites in both 2013/ 14 *Maha* and 2014 *Yala* seasons (Table 1 and 2) were higher than the usual range in irrigation water given by the FAO (0 - 2 mg/ l) (FAO, 1985). This K enriched irrigation water is one of the main natural sources of K for the plant growth in the irrigated cropping systems. Therefore, the contribution of K from the irrigation water should be

considered in site specific fertility management in the rice - OFCs cropping systems in the Mahaweli System 'H' areas.

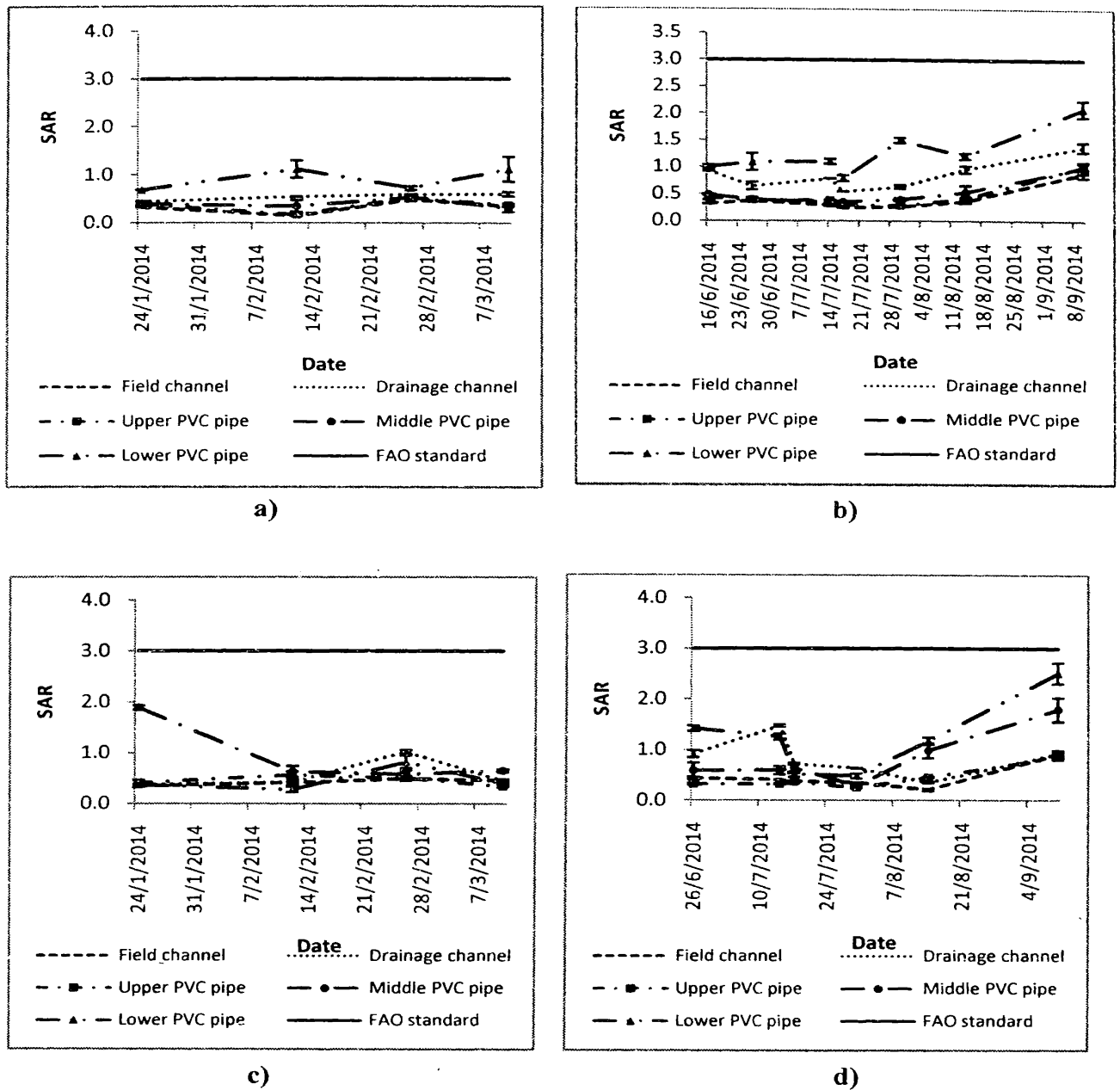


Figure 8. Temporal variability of the SARs in the irrigation and the shallow ground water in Thalawa site during (a) 2013/ 14 Maha, (b) 2014 Yala and Galnewa site during (c) 2013/ 14 Maha, (d) 2014 Yala

CONCLUSIONS

The levels of EC_w , pH, Na, Ca and SAR in irrigation water, drainage water and the shallow ground water in the selected investigation sites in Thalawa and Galnewa areas of the Mahaweli System 'H' are within the usual range specified under the FAO standards for irrigation. Comparatively higher concentrations of Mg and K were found throughout both 2013/ 14 *Maha* and 2014 *Yala* seasons in rice - other field crops cropping systems in the study areas. Further, the Mg and the Na contents are at comparatively higher levels in the shallow ground water in the lower positions of the landscape and in drainage water indicating the lateral and the vertical leaching of those ions from the soil to the water. Comparatively higher levels of pH as well as the Ca and K concentrations are found in the field irrigation water in the study areas throughout both cropping seasons. The contribution of K from the irrigation water should be taken in to consideration in site specific fertility management in the rice - OFCs cropping systems in the Mahaweli system 'H' areas.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the financial assistance provided by the Council for Agriculture Research Policy (CARP) through National Agriculture Research Plan (NARP) to conduct this research project. The authors greatly acknowledge the assistance given by the Mahaweli Authority of Sri Lanka to execute the research project in a smooth manner.

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