Chapter 7. Soil Water Capacities

7.1 Soil Water Retention Characteristic of Soil Groups

The soil water retention characteristic of Horizons A and B1 was measured for 32 soil types across 61 sites. To determine the soil water retention characteristic, volumetric water contents of Horizons A and B1 were measured at matric suction 0 kPa (saturation), 10 kPa (field capacity), 60 kPa (refill point) and 1500 kPa (permanent wilting point). Results are summarised in Tables 7.1 and 7.2. In general, Group 1 has the lowest water content and Group 5 the highest for a given matric potential for both Horizons A and B1. There is some difference between Groups 2, 3, 4 and 6, but the difference is small for Horizon B1. Horizon B1 tends to have higher water content than Horizon A for a given matric potential. For a given matric potential, volumetric water content of Horizon A of Groups 2 and 3 is not found significantly different when their means are compared in a t-test. The same is found for Groups 3 and 4 of Horizon A, and Groups 5 and 6 of Horizon B1. Horizon B1 generally has a larger standard deviation of water content at a given suction than Horizon A.

Table 7.1 Average Soil Water Content of Horizon A at Various Matric Suctions

Soil Group	No of Points	Volumetric Water Content (%)									
		0 kPa		10 kPa		60 kPa		1500 kPa		AWC0	AWC
		Avg.	Std.	Avg.	Std.	Avg.	Std.	Avg.	Std.		
1	18	40.0	4.3	31.0	7.0	25.6	7.8	13.8	5.5	26.2	17.2
2	36	43.3	6.8	38.4	6.1	34.1	5.9	23.7	5.8	19.6	14.6
3	37	43.9	6.0	37.2	6.2	33.2	5.9	23.9	5.3	20.0	13.3
4	16	42.6	5.7	38.5	5.4	34.7	5.5	26.5	5.6	16.1	12.1
5	8	48.4	4.3	44.6	2.7	42.3	2.8	34.4	3.7	14.0	10.2
6	16	45.5	8.4	40.1	5.3	36.9	5.4	29.8	5.1	15.7	10.3

Table 7.2 Average Soil Water Content of Horizon B1 at Various Matric Suctions

Soil Group	No of Points	Volumetric Water Content (%)									
		0 kPa		10 kPa		60 kPa		1500 kPa		AWC0	AWC
		Avg.	Std.	Avg.	Std.	Avg.	Std.	Avg.	Std.		
1	18	37.2	4.5	29.8	7.6	25.2	7.9	16.7	8.3	20.5	13.1
2	36	45.1	4.9	41.8	5.4	38.4	5.5	29.3	5.2	15.8	12.5
3	42	43.8	6.8	38.8	6.8	35.1	7.0	26.9	6.3	17.0	12.0
4	16	47.5	6.0	43.3	5.7	39.7	6.3	29.6	6.8	17.9	13.7
5	8	51.2	8.0	46.0	6.2	44.0	6.4	33.7	5.3	17.5	12.3
6	16	49.5	8.9	44.3	6.9	41.0	7.0	31.7	6.2	17.8	12.6

Box and whisker plots of water content data for Horizons A and B1 are presented in Figures 7.1, 7.2, 7.3 and 7.4 to show the distribution of water content at various matric

suctions within soil groups. The distribution of some soil groups is skewed due to a few large values. For Groups 2, 4 and 5, the band between the upper and lower quartiles of soil groups are generally narrow for a given matric suction, which suggests that median values could be used as indicative values for the respective soils for practical applications.

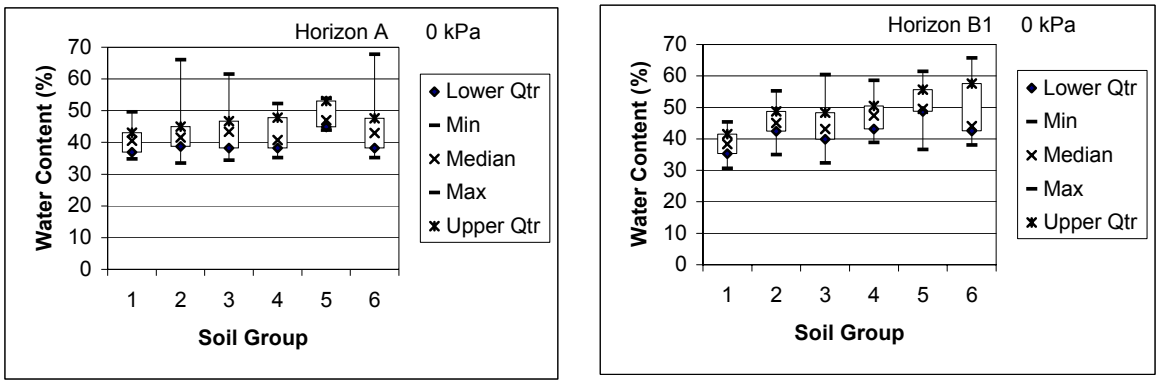

Figure 7.1 Volumetric Water Content of Horizons A and B1 at Saturation (0 kPa)

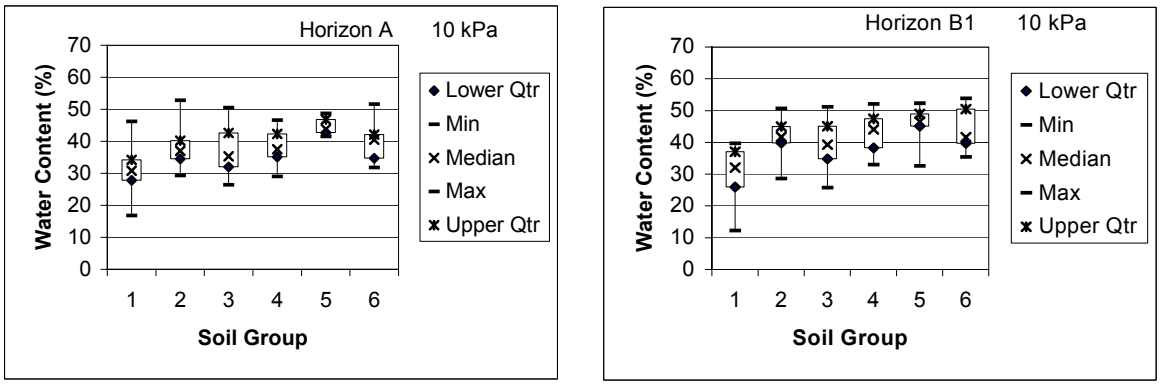

Figure 7.2 Volumetric Water Content of Horizons A and B1 at 10 kPa Matric Suction

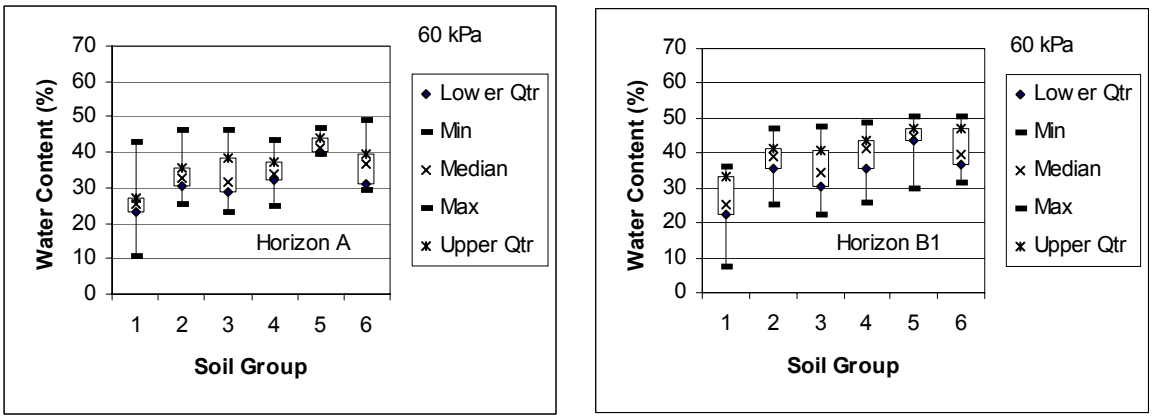

Figure 7.3 Volumetric Water Content of Horizons A and B1 at 60 kPa Matric Suction

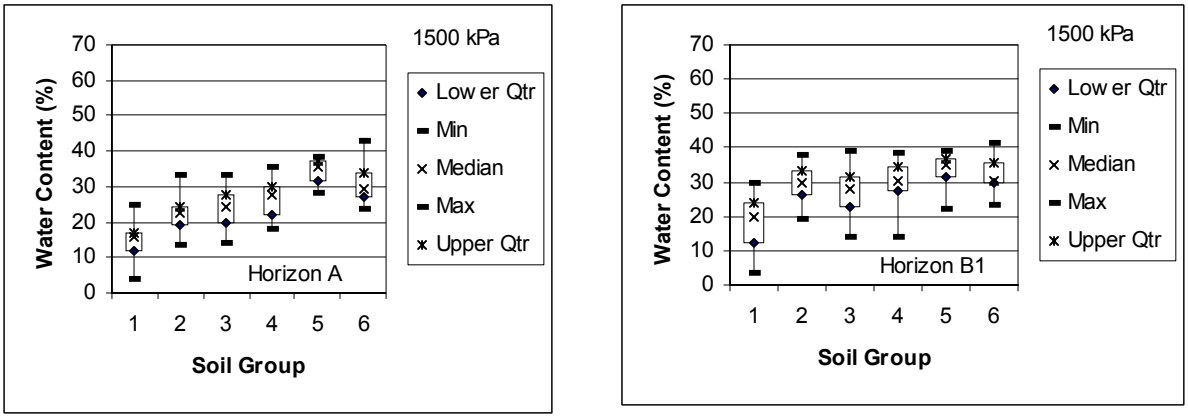

Figure 7.4 Volumetric Water Content of Horizons A and B1 at 1500 kPa Matric Suction

7.2 Soil Water Retention Characteristic of Soil Types

Table 7.3 shows soil water characteristic data of Horizon A for 32 soil types. Sandmount sand of Group 1 has the lowest and Wallenjoe clay of Group 6 has the highest water content at 1500 kPa matric suction. Groups 2 and 5 showed less between-soil-type variability of water content at a given matric suction. On the other hand, Groups 1, 3 and 6 showed large between-soil-type variability of water content. Therefore, it is suggested to use water contents of soil types of these groups for the estimation of soil water retention characteristic.

Table 7.3 Soil Water Retention Characteristic of Horizon A

Soil Group	Soil Type	No. of Points	Volumetric Water Content (%)								Avg. AWC0 (%)	Avg. AWC (%)
			0 kPa		10 kPa		60 kPa		1500 kPa			
			Avg.	Std.	Avg.	Std.	Avg.	Std.	Avg.	Std.		
1	Sandmount sand	2	42.7		19.8		12.4		4.2		38.5	15.6
	Sandmount sand phase	2	35.4		27.3		22.5		10.2		25.2	17.1
	East Shepparton fine sandy loam	6	38.5	3.6	28.8	2.6	24.9	3.3	15.5	5.2	23.0	13.3
	Nanneella fine sandy loam	8	41.5	4.7	36.3	6.1	30.2	7.8	15.9	4.1	25.7	20.4
2	Katamatite loam	2	49.0		45.1		42.6		31.7		17.4	13.5
	Waaia loam	4	43.6	3.1	40.2	3.1	32.7	1.9	22.0	2.8	21.6	18.2
	Waaia loam phase	2	52.2		49.5		46.1		33.9		18.3	15.6
	Timmering loam	6	48.0	9.9	40.5	7.4	35.2	7.0	24.6	6.5	23.4	15.9
	Cobram loam	8	42.9	5.0	37.2	5.2	33.1	4.6	23.1	3.4	19.8	14.0
	Moira loam friable phase	4	38.2	5.2	35.7	4.6	32.7	3.9	20.3	2.7	17.9	15.4
	Shepparton fine sandy loam	10	39.7	2.7	34.7	2.5	31.3	2.8	22.1	5.7	17.6	12.6
3	Lemnos loam friable phase	4	43.7	4.7	37.9	5.1	33.7	4.9	21.4	3.3	22.3	16.4
	Lemnos loam semi friable phase	2	40.9		29.9		25.5		17.4		23.5	12.5
	Lemnos loam	15	46.1	7.0	38.4	7.3	34.5	7.0	25.2	5.0	21.0	13.2
	Moira loam	2	42.0		34.6		31.5		15.9		26.1	18.7
	Naring loam	5	39.9	4.9	34.0	6.1	30.5	5.7	21.9	4.9	18.0	12.1
	Wanalta loam	7	45.1	4.5	40.5	3.4	35.4	4.4	28.8	3.2	16.3	11.8
	Goulburn loam friable phase	2	37.8		34.2		30.5		21.8		16.0	12.3
4	Goulburn loam	6	41.8	5.8	38.6	6.0	35.5	5.9	24.9	5.2	16.8	13.6
	Wana loam	2	51.7		46.4		42.7		35.6		16.0	10.8
	Koyuga clay loam	4	39.9	3.5	35.5	4.3	31.5	4.9	25.1	4.7	14.8	10.3
	Koga clay loam	4	42.0	5.3	37.6	3.7	32.7	3.0	25.5	4.8	16.5	12.2
	Congupna clay loam	2	48.6		43.0		41.1		36.3		12.3	6.7
5	Ulupna clay	2	46.0		44.3		42.6		34.9		11.1	9.4
	Rochester clay	2	45.5		43.0		40.1		33.2		12.4	9.9
	Alta clay loam	2	53.5		48.0		45.5		33.2		20.3	14.8
	Congupna clay	2	48.0		41.5		37.2		27.9		20.0	13.6
6	Muckatah clay loam	6	39.9	4.6	36.9	5.3	34.3	5.6	29.0	4.9	10.9	7.9
	Boosey loam friable phase	2	43.7		39.9		36.1		26.0		17.7	13.9
	Boosey loam	2	40.5		37.4		34.3		31.2		9.2	6.1
	Wallenjoe clay	2	62.4		47.5		44.6		38.4		24.0	9.1
	Carag clay	2	50.2		44.0		40.2		28.4		21.8	15.7

Table 7.4 shows soil water retention characteristic data of Horizon B1 for 32 soil types. Similar to Horizon A, Sandmount sand of Group 1 has the lowest and Wallenjoe clay of Group 6 has the highest water content at 1500 kPa matric suction. Except for Group 2, Horizon B1 has larger between-soil-type variability of water content at a given matric suction than Horizon A.

Table 7.4 Soil Retention Characteristics of Horizon B1

Soil Group	Soil Type	No. of Points	Volumetric Water Content (%)								Avg. AWC0 (%)	Avg. AWC (%)
			0 kPa		10 kPa		60 kPa		1500 kPa			
			Avg.	Std.	Avg.	Std.	Avg.	Std.	Avg.	Std.		
1	Sandmount sand	2	39.7		16.1		10.0		4.0		35.7	12.1
	Sandmount sand phase	2	32.7		25.3		20.8		9.0		23.7	16.3
	East Shepparton fine sandy loam	6	34.3	3.7	28.0	4.7	25.3	5.1	18.6	7.5	15.7	9.4
	Nanneella fine sandy loam	8	39.8	3.9	35.7	4.2	29.9	5.6	20.3	6.7	19.5	15.4
2	Katamatite loam	2	42.8		37.6		33.8		23.6		19.3	14.0
	Waaia loam	4	48.2	5.0	44.6	4.4	37.9	3.3	28.6	4.0	19.5	16.0
	Waaia loam phase	2	49.1		45.7		43.1		33.2		15.9	12.5
	Timmering loam	6	47.1	5.6	43.7	6.8	40.0	6.9	32.1	6.2	15.0	11.6
	Cobram loam	8	42.3	4.2	37.5	4.7	34.0	4.7	25.7	4.3	16.6	11.8
	Moira loam friable phase	4	43.5	2.1	41.7	1.4	39.5	1.3	29.5	2.5	14.0	12.2
	Shepparton fine sandy loam	10	45.2	5.0	43.3	4.9	40.7	5.0	31.1	4.7	14.2	12.2
3	Lemnos loam friable phase	4	45.5	4.9	38.2	5.8	34.2	5.5	23.5	4.3	21.9	14.6
	Lemnos loam semi friable phase	2	43.6		36.5		32.8		28.2		15.5	8.3
	Lemnos loam	18	42.7	4.8	39.0	5.8	35.2	6.2	27.1	6.1	15.7	11.9
	Moira loam	2	40.1		34.8		32.1		22.6		17.5	12.1
	Naring loam	6	40.3	8.5	36.8	10.0	33.9	10.5	26.0	8.1	14.3	10.8
	Wanalta loam	8	47.4	9.8	40.7	8.3	36.5	8.7	28.2	7.4	19.2	12.5
	Goulburn loam friable phase	2	50.7		43.6		39.1		31.6		19.2	12.0
4	Goulburn loam	6	42.9	4.9	39.6	6.1	36.2	7.7	24.8	8.0	18.2	14.9
	Wana loam	2	48.4		44.6		42.1		37.3		11.2	7.3
	Koyuga clay loam	4	49.8	4.9	46.5	4.3	42.7	4.5	33.3	2.3	16.5	13.2
	Koga clay loam	4	51.7	6.4	45.2	6.1	40.7	6.0	29.4	3.7	22.3	15.8
	Congupna clay loam	2	48.7		45.2		43.3		31.6		17.1	13.6
5	Ulupna clay	2	45.2		42.4		40.1		30.6		14.6	11.8
	Rochester clay	2	49.4		47.7		45.9		36.2		13.2	11.4
	Alta clay loam	2	61.4		48.6		46.7		36.3		25.1	12.3
	Congupna clay	2	45.6		39.0		35.1		26.9		18.7	12.1
6	Muckatah clay loam	6	46.9	8.6	43.6	7.3	40.7	6.7	31.4	4.0	15.5	12.2
	Boosey loam friable phase	2	43.8		38.3		33.6		23.7		20.1	14.7
	Boosey loam	2	43.3		41.9		39.7		30.4		12.9	11.5
	Wallenjoe clay	2	62.5		51.0		47.8		40.2		22.3	10.8
	Carag clay	2	59.9		53.6		49.5		38.0		22.0	15.6

7.3 Soil Water Retention Curve of Selected Soil Types

To determine soil water retention characteristic curve, volumetric water contents of Horizons A and B1 were measured at matric suction of 0, 1, 5, 8, 10, 60, 80, 200 and 1500 kPa. Detailed soil water retention characteristic was measured for 15 soil types. Figures 7.5 and 7.6 show the plot of soil water characteristic curve of Horizons A and B1 of the selected soil types. Sandmount (Ss) sand soil has different shape of soil retention characteristic of Horizons A and B1 than other soil types. Other soils have almost similar shape of soil water characteristic of Horizons A and B1. For Horizon B1, Koyuga clay loam (Kycl) and Nanneella fine sandy loam (Nfsl) also have relatively different water contents at a given matric suction than other soils.

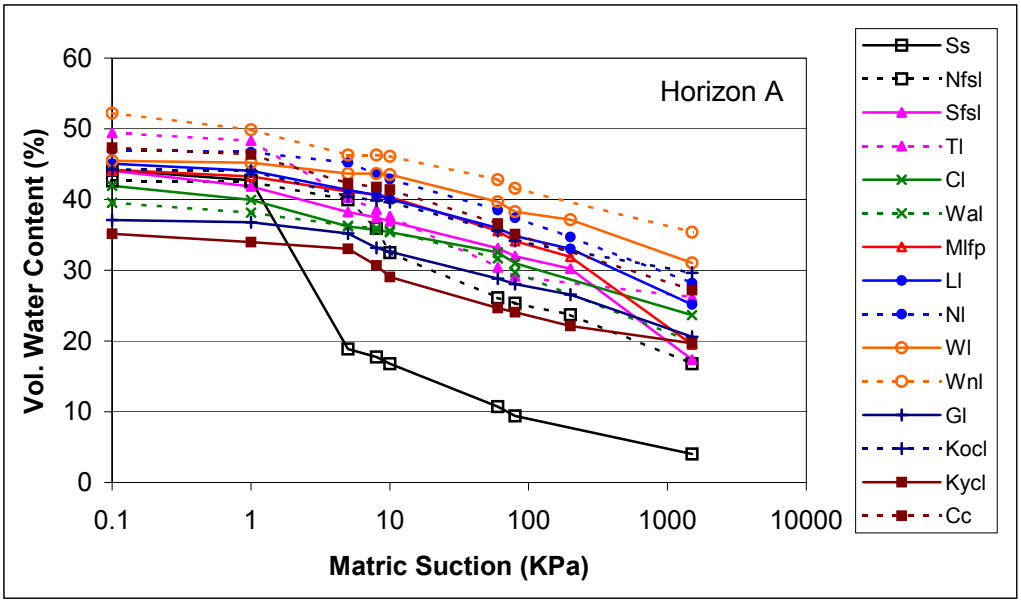

Figure 7.5 Soil Water Retention Characteristic of Horizon A of Some Major Soil Types

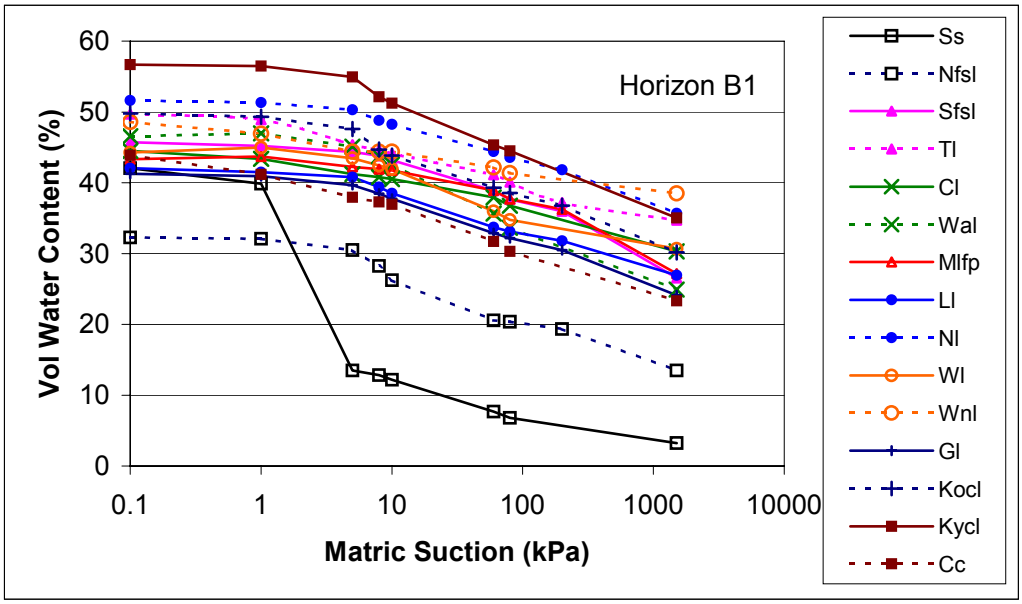

Figure 7.6 Soil Water Retention Characteristic of Horizon B1 of Some Major Soil Types

7.4 Soil Water Capacities

Soil water capacities, AWC and AWC0, of Horizons A and B1 were calculated. Results are summarised in Tables 7.1, 7.2, 7.3 and 7.4. Figure 7.7 shows a comparison of the average soil water capacities of Horizons A and B1. In general, Group 1 has the highest soil water capacities for both Horizons A and B1. It appears that the soil water capacities decrease from Group 1 to Group 5. This pattern does not hold for Horizon B1. For Horizons B1, Groups 2 and 3 tends to have the lowest AWC0 among soil groups. It is also noted that the difference between groups in soil water capacities is less in Horizon B1 than Horizon A. For Groups 1, 2 and 3, Horizon A has greater soil water capacities than Horizon B, while the reverse is true for Groups 4, 5 and 6.

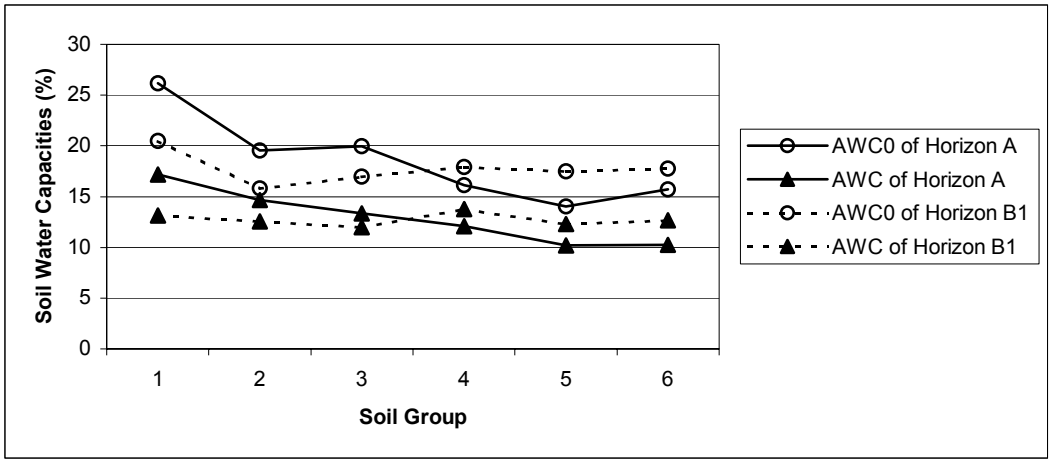

Figure 7.7 Average Soil Water Capacities of Soil Groups

Figures 7.8 and 7.9 show box and whisker plots of AWC of Horizons A and B1 respectively of soil groups. For Groups 3, 4 and 5 of Horizon A, the bands between upper and lower quartiles are relatively narrow to suggest that the average values could be used as indicative values for the respective soils for practical applications. For Groups 1, 2 and 6 it suggested to use average value of soil type if available.

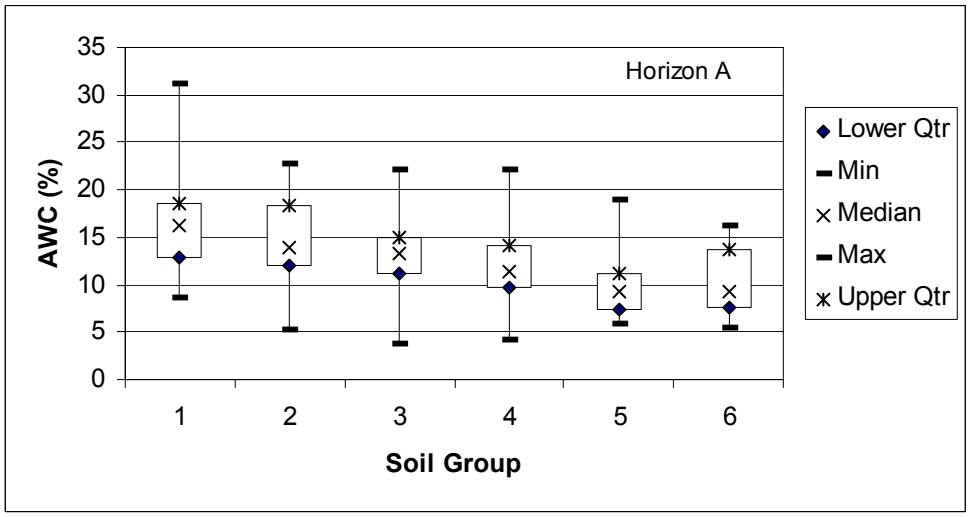

Figure 7.8 Available Water Capacity (AWC) of Horizon A

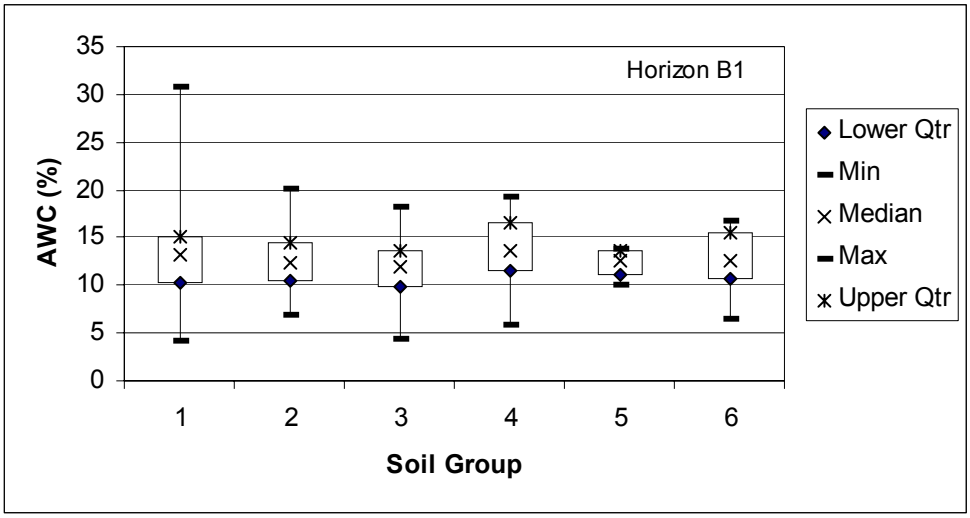

Figure 7.9 Available Water Capacity (AWC) of Horizon B1

7.5 Available Water

For a given soil depth, available waters in depth, AW and AW0, can be calculated by multiplying AWC and AWC0 by the soil depth respectively. Table 7.5 shows results for an assumed rooting depth of 300 mm, which is a rooting depth of commonly grown pasture crop in the SIR. Figure 7.10 shows a comparison of available water of Horizon A and of a soil depth of 300 mm. Group 1 has the highest available water, AW and AW0, and Group 6 the lowest. It appears that available water decreases from Group 1 to Group 6. AW of Groups 3 and 4 shows little difference. It should be noted that rooting depth may also vary with soil and irrigation regime. AW and AW0 may therefore depend upon factors other than soil water capacities.

Table 7.5 Average Available Water in Horizon A and in a Rooting Depth of 300 mm

Soil Group	Horizon A			Rooting Depth of 300 mm	
	Depth (mm)	AW (mm)	AW0 (mm)	AW (mm)	AW0 (mm)
1	196	33.6	51.4	46.9	72.4
2	185	27.1	36.6	41.4	54.5
3	170	22.3	33.6	37.5	55.3
4	186	22.5	30.1	38.1	50.5
5	176	17.9	24.6	33.2	46.3
6	190	16.6	27.2	29.6	45.6

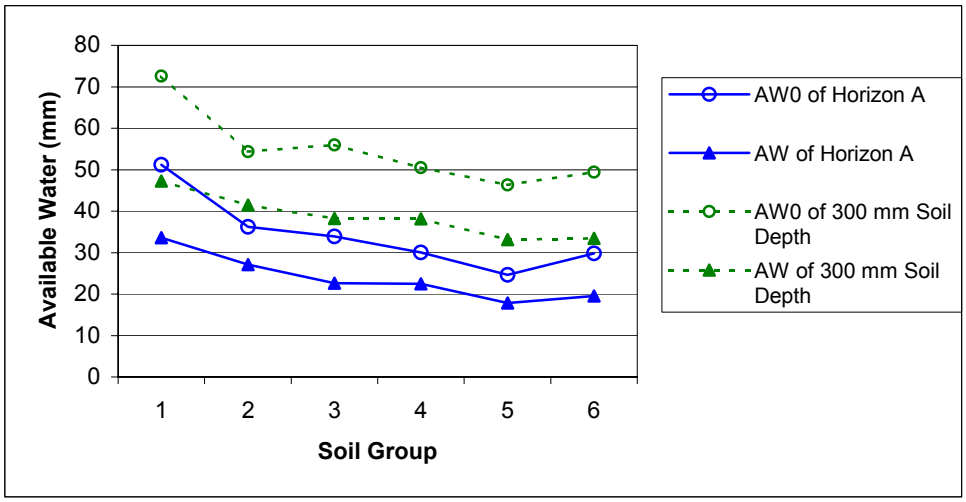

Figure 7.10 Available Water of Horizon A and 300 mm Soil Depth

7.6 Conclusions

Soil water retention characteristic of 32 soil types of Horizons A and B was measured across 56 sites in the SIR.

Soil available water capacities of Horizons A and B1 is reasonably well defined for Groups 3, 4, 5 and 6, and it is recommended that the average values of these groups could be used as indicative values for practical applications. For Groups 1 and 2, it is suggested to use average values of soil types.

Some trends of available water capacities across the soil groups have been found. Available water capacities of Horizon A decrease from Group 1 to Group 5. This pattern does not hold for Horizon B1. In terms of soil water capacities, Horizon A is greater than Horizon B for Groups 1, 2 and 3, while the reverse is true for Groups 4, 5 and 6.