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Characterization of Soils at Angacha District in Southern Ethiopia

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Abstract

The study was conducted at Angacha Research Station in Kembata Tembaro Zone of Southern Ethiopia to characterize the soils of the research station. A pedon with 2 m x 2 m x 1.5 m volume was opened and horizons were described in situ. Samples were collected from all identified horizons for laboratory analysis. The physico-chemical characteristics of the soil showed that the soil has good soil fertility status but organic carbon (OC) content was medium (1.56%). The soil type of the research station was identified to be Alfisols. Organic carbon (OC), total N, and K contents of the soil, ranging between 0.5 and 1.56%, 0.06 and 0.25%, and 0.19 and 0.37 Cmol (+) kg^{-1}, respectively, and decrease with depth, whereas the available P content is the same (40 ppm) throughout the horizons. Therefore, it is concluded that soil fertility management practices based on the findings should focus on maintaining and increasing OC and N content of the soil and monitoring for balances among nutrients.

Key words*:* Argillic, Alfisols, Soil characterization

Introduction

Soil can be characterized by its structure, color, consistence, texture, and abundance of roots, rocks, and carbonates. These characteristics allow scientists to interpret how the ecosystem functions and make recommendations for soil use that have a minimal impact on the ecosystem. For example, soil characterization data can help determine whether a garden should be planted or a school should be built. Soil characterization data can help scientists predict the likelihood of flooding and drought. It can help them to determine the types of vegetation and land use best suited to a location (Globe, 2005).

Characterization of soils is fundamental to all soil studies, as it is an important tool for soil classification, which is done based on soil properties. Soil characterization also helps to document soil properties at research sites, which is essential for the successful transfer of research results to other locations (Buol *et al*., 2003). Therefore, it is important to characterize the soil of the research site and further investigate the soil type although the soil of the area is broadly said to be Ultisols (Ministry of Agriculture, 1995).

Most soils have a distinct profile, which is a vertical section of soil through all its horizons and extends up to the parent materials or it is sequence of horizontal layers (Pidwirny, 2007). Generally, these horizons result from the processes of chemical weathering, eluviations, illuviation, and organic decomposition. A study of soil profile is important both from the standpoint of soil formation and soil development (pedology) and crop husbandry (edaphology) since it reveals the surface and the subsurface characteristics and qualities, namely depth, texture, structure, drainage conditions and soil-moisture relationships. In deep soils the soil profile may be studied up to one meter and a quarter and in others up to the parent material. The layers (horizons) in the soil profile which vary in thickness may be distinguished from the morphological characteristics which include colour, texture, structure, etc. Generally, the profile consists of 3 mineral horizons 'A', 'B' and 'C'.

The 'A' horizon may consist of sub-horizons richer in organic matter intimately mixed with mineral matter. The 'B' horizon is below the'A' horizon showing dominant features of concentration of clay, iron, aluminum of humus alone or in combination. The C horizon is composed of weathered parent material.

Soils widely vary in their characteristics and properties. In order to establish the interrelationship between their characteristics they require to be classified. Understanding the properties of the soils is important in respect of the optimum use they can be put to and for their best management requirements. It helps to group together such soils as have comparable characteristics so that the knowledge regarding them is presented in a systematic manner. To classify soils and group them together in a meaningful manner different systems of soil classification have been used from time to time. The modern system of classification "Soil Taxonomy", which has six categories: order, sub-order, great group, sub-group, family and series, developed by the USDA has been recommended for adoption all over the world. According to this system of soil classification, soils are classified in to Entisols, Inceptisols, Alfisols, Vertisols, Ultisols, Oxisols, Aridisols, Histosols, Gelisols, Andisols, Molisols.

Alfisols are widely used for agriculture because of its natural fertility, location in humid and sub humid regions, and responsiveness to good management. The central concept of Alfisols is that of forest soils, which occupy relatively stable landscape positions and thus have a subsurface zone of clay accumulation (Buol *et al*., 2003).

Five prerequisites are met by soils of Alfisol-dominated landscapes: (1) accumulation of enough layer lattice clay (of any species) in the sub soil (often a Bt horizon) to form argillic (Buol *et al*., 2003; Landon, 1984; Young, 1976; Bridges, 1970), kandic, or natric horizons, (2) relatively high base (calcium, magnesium, potassium, and sodium) status, with base saturation by sum of cations greater than 35% in the lower part of or below the argillic or kandic horizon and usually increasing with depth, (3) contrasting soil horizons, which under deciduous forest include O, A, E, and Bt, with the possibility in various ecosystems of the presence of natric, petrocalcic, duripan, and fragipan horizons, and plinthite, (4) favorable moisture regimes (aquic, cryic, udic, ustic, and xeric soil moisture regimes), with water available to mesophytic plants more than half the year or for three consecutive months in a warm season; and (5) relatively little accumulation of organic matter in mineral soil horizons (most organic matter is naturally cycled in the O horizon), particularly in cultivated areas (Buol *et al*., 2003).

Alfisols are used for cultivated crops, winter (hardy) hayland, pasture, range, and forest. The relatively high base saturation of most pedons and the presence of large reserves of plant nutrients in the more highly base-saturated C horizon indicate the native fertility of these soils (Buol *et al*., 2003). Alfisols are perhaps one of the most intensively utilized body of soils in Ethiopia where the subsistence sector places much dependence on native fertility and rainfall. They have good physical and chemical characteristics and are found in those regions that are climatically favorable. As in other soils, nitrogen is probably more often deficient here than any other essential element. Under normal cropping conditions and soil management, immobilization and mineralization tend to balance each other in magnitude to render the system in equilibrium. Because organic matter is not maintained, its formation and decomposition with subsequent mineralization does not determine the parallel gains and losses of soil nitrogen and other nutrients (Mesfin, 1998).

In order to know the soil fertility status and accordingly determine the best management, characterization of the soil at the site is required. This study was therefore initiated with the objective to characterize and classify the soil of Angacha research station.

Materials and Methods

Description of the Study Site

The study was conducted at Angacha research station, which is located in Southern Nations Nationalities and People's Regional State (SNNPRS), Kembata Tembaro Administrative Zone. It is located at about 260 km South of Addis Ababa and 2 km south to Angacha town, found at 7^{0} 03' N and 38^{0} 29' E and altitude 2381m asl. The mean annual rainfall is 1656 mm with a bimodal pattern that extend from February to September. The peak rainy months are April, July, August and September (Table 5a). The mean annual maximum temperature is 24 ^{0}C and monthly values range between 23 and 24 ^{0}C (Table 5b). The mean annual minimum temperature is 14 ^{0}C and monthly values range between 13 and 14 ^{0}C (Table 5c). The coldest months are June and August, whereas February is the hottest month (Table 5a).

Soil Characterization and Sampling

A 2 m x 2 m x 1.5m soil pit was excavated at a representative spot in the Research station. The soil profile was described in situ following guidelines for soil description (FAO, 1990).

Soil samples were collected from every identified horizon of the profile and surface soil (0-30cm).

Laboratory Analyses

All Laboratory analyses were done following the procedures in laboratory manual prepared by Sahlemedhin and Taye (2000). The soil samples were air-dried and ground to pass a 2-mm sieve and 0.5 mm sieve (for total N) before analysis. Soil texture was determined by Bouyoucos hydrometer method. The pH and electrical conductivity of the soils were measured in water (1: 2.5 soil: water ratio). Organic carbon content of the soil was determined following the wet combustion method of Walkley and Black. Total nitrogen content of the soil was determined by wet-oxidation (wet digestion) procedure of Kjeldahl method. The available phosphorus content of the soil was determined by Bray II method. Exchangeable cations and the cation exchange capacity (CEC) of the soil were determined following the 1 N ammonium acetate (pH 7) method. The exchangeable K and Na in the extract were measured by flame photometer. Calcium and magnesium were measured using EDTA titration method. The available potassium was determined by Morgan's extraction solution and potassium in the extract was measured by flame photometer. Exchangeable acidity of the soil was determined by leaching exchangeable hydrogen and aluminum ions from the soil samples by 1 N potassium chloride solution.

Results and Discussion

Physico-chemical Properties and Classification of Soils of Angacha Research Station

The soil of the Research Station that covers an average of 5 ha is well drained and permeable that occurs on land of 6% slope (Table 4). The color of the surface soil is light reddish brown when dry and dark reddish brown when moist. The color changed to grayish with depth (Table 1). Its organic carbon (OC) content ranged between 0.5 and 1.56% and decreases with depth (Table 2). The moist color value and chroma, OC content and percent base saturation (PBS) meet Mollic epipedon criteria. The results of the particle size analysis indicated that the textural classes of the soil of the research station are clay loam at upper horizons and silty loam at Bt_2 horizon (Table 2). This could be probably due to clay migration within the profile. Clay content in the soil ranged from 30 to 42% and increased with depth. These Bt_1 and Bt_2 horizons are more than 30 cm thick and have apparent cation exchange capacity (CEC_7) values of 40 and 31 cmol kg^{-1} clay, respectively. The Bt horizons contained 38 and 42 percent clay, which are more than 1.2 times as much clay as the A horizon above. The soil is very deep (>150 cm) and has an angular blocky structure with good porosity and clear textural boundary. Based on these features and the clay films (argillans) detected in these horizons, the sub surface horizons are termed as argillic.

The base saturation percentage (BSP) is greater than 50% by ammonium acetate at pH 7 throughout the profile. According to Buol *et al*. (2003), the 50% base saturation determined by the ammonium acetate method (CEC_7) is roughly equivalent to 35% base saturation by sum of cations mathod ($CEC_{8.2}$). Thus, the argillic horizons had base saturation greater than 35%. The profile has an A and Bt horizons with accumulation of enough clay in the Bt horizons. There is also relatively high base status in the argillic horizon. Besides these, the organic carbon (OC) content in the mineral horizons is relatively low. The properties qualify the soil as an order of Alfisol of the soil Taxonomy with a suborder and great group of Udalfs and Hapludalfs, respectively. The equivalent FAO/Unesco soil classification is Haplic Luvisol. Alfisols are widely used for agriculture because of its natural fertility, location in humid and sub humid regions, and responsiveness to good management. The central concept of Alfisols is that of forest soils that occupies relatively stable landscape positions and thus has a subsurface zone of clay accumulation (Buol *et al*., 2003).

The pH of the soil is moderately acidic (Herrera, 2005) with values ranging between 6 and 6.62. This pH value indicates that there is no toxicity of aluminum, manganese and hydrogen; rather cations such as K, Ca and Mg are abundant (Fall, 1998). The pH values increased with soil depth because less H^+-ions are released from decreased organic matter decomposition, which is caused by decreased organic matter content with depth and this is in agreement with Buol *et al*. (2003). The electrical conductivity of the soil ranged between 0.05 in Bt_1 horizon and 0.16 dS m^{-1} in Bt_2 horizon indicating that it has no salinity problem (McWilliams, 2003). Higher concentrations of bases (K, Ca and Mg) are observed in the surface horizon meeting one of the requirements of Alfisols (Buol *et al*., 2003).

The total N content of the soil ranged between 0.06% in Bt_2 horizon and 0.25% in A horizon (Table 2). Its content decreased with depth due to decreased organic matter content down the profile that is in agreement with Buol *et al*. (20003). The C: N ratio of the soil ranged between 6.24 at the A horizon and 10.8 at theBt_2 horizon.

According to Landon (1991), the cation exchange capacity (CEC) of the soil is medium ranging between 12.88 and 18.08 cmol (+) kg^{-1} of soil. The value decreases with depth. This range of CEC indicates that the dominant clay mineral of the soil is illite as Buol *et al*. (2003) indicated the CEC range for soil dominated by this clay mineral to be between 10 and 40 cmol(+) kg^{-1} of soil. Alfisol is one of the soil orders in which this mineral is an important constituent of clays (Tan, 1993).

According to this author, K^+ ions exert electrostatic bond in the interlayer of illite and link the unit layers together not to expand up on addition of water. As a result of this, illite is potassium reservoir (Landon, 1991) and known to be potassium rich (Keene *et al*., 2004). The exchangeable potassium of the soil ranged between 0.19 and 0.37 cmol (+) kg^{-1} of soil. The value decreased from 0.37 cmol (+) kg^{-1} of soil at A horizon to 0.19 cmol (+) kg^{-1} of soil at Bt_1 horizon but started to increase at Bt_2 horizon. The soil has low available potassium (Landon, 1991), which is similar throughout the profile being in agreement with Foth (1990). The low availability might be attributed to fixation.

The exchangeable sodium content of the soil is 0.4 cmol (+) kg^{-1} of soil throughout the profile. The exchangeable sodium percentage (ESP) ranged between 3.9 and 8.3, which indicates that the soil has no sodicity problem (Herrera, 2005). Higher ESP values were obtained at bottom horizons than the upper one, which could be attributed to adsorption of Ca and Mg at the soil surface. The exchangeable acidity is also low ranging between 0.02 at A horizon and 0.10 cmol (+) kg^{-1} of soil at Bt_2 horizon. The soil has no exchangeable aluminum throughout the profile and hence acquired its exchangeable acidity only from the exchangeable H.

The analysis of soil sampled collected from the surface soil (0-30cm) indicated that the pH and C:N ratio of the soil is lower than the sub surface soil. Total nitrogen, organic carbon, exchangeable bases (K, Ca, and Mg), CEC, available P, and available K are higher in the surface soil than in the sub soil. This showed that more nutrients are concentrated in the surface soil than in the sub soil of the experimental area implying the agricultural crops grown on this soil can access nutrients in their rooting depth. Particularly P and K are by far higher in the surface soil than in the sub soil. Generally the soil is fertile satisfying one of the requirements of Alfisols (Buol *et al*., 2003). Nitrogen is also higher although the difference between the surface soil and the sub soil is not as wide as the difference in the case of P and K. The analysis indicated that the P and K are very implying the soil does not respond to application of P and K fertilizers. Although the nitrogen content of the soil is higher in the surface soil than in the sub soil, the rating is lower implying the soil can highly respond to application of N fertilizers. The organic carbon (OC) content of the surface soil is 1.6% (Table 3). Herrera (2005) classified OC as very low (<0.6%), low (0.6-1.16%), moderate (1.16-1.74%) and high (>1.74). According to this classification, the OC content of the experimental soil is moderate. The pH is in the range in which most nutrients are available to plants so the soil of the experimental area is good for crop production. Therefore, agricultural practice should involve application of N fertilizer and maintenance of other nutrients including organic carbon.

Conclusion

The soil of Angacha Research Station has good soil fertility status and pH range, where nutrients are easily available for satisfactory crop production. However, total nitrogen is low and soil organic matter content is medium. Therefore, soil fertility management practices should focus on maintaining and increasing OC and N content of the soil and monitoring for balances among nutrients.

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Table 1. Selected Morphological Properties of the Soil Profile at Angacha Agricultural Research Station

Horizon symbol	Depth (cm)	Color		Texture (Feel method)	Structure	Consistency			Boundary
		Dry	Moist			Dry	Moist	Wet	
A	0-69	5YR6/3	5YR3/2	Clay Loam	Angular blocky	Slightly hard	Friable	Ssvp	Clear weavy
Bt_1	69-96	5YR6/2	5YR3/2	Clay Loam	Angular blocky	Slightly hard	Friable	ssvp	Clear weavy
Bt_2	96-150+	5YR7/2	5YR4/2	Clay Loam	Angular blocky	Slightly hard	Friable	ssvp	Clear weavy

Ssvp-slightly sticky-very plastic

Ssvp- slightly sticky-very plastic

Ssvp- slightly sticky-very plastic

Table 2. Selected Physicochemical Properties of the Soil Profile at Angacha Agricultural Research Station

Depth (cm)	Particle size distribution (%)			Textural Class	pH (H_2O)	EC (dS m^{-1})	N (%)	OC (%)	C/N	Exchangeable bases (cmol(+) kg^{-1})					EA cmol(+) kg^{-1}	BSP (%)	ESP (%)	Av P mg/kg	Av. K mg/kg
	Sand	Silt	Clay							Na	K	Ca	Mg	CEC					
0-69	34	36	30	CL	6.46	0.051	0.25	1.56	6.24	0.4	0.37	12.0	1.5	18.08	0.015	78.9	3.91	40	94
69-96	24	38	38	CL	6.62	0.049	0.11	0.5	4.55	0.4	0.19	10.6	1.4	15.24	0.099	82.6	8.33	40	94
96-150+	16	42	42	SL	6.56	0.16	0.06	0.65	10.8	0.4	0.28	8.3	1.4	12.88	0.023	80.6	6.76	40	94

CL- Clay Loam, SL- Silty Loam, EC-Electrical conductivity, OC- Organic carbon, C/N- Carbon to Nitrogen ratio, EA- Exchangeable acidity, BSP- Base saturation percentage, ESP- Exchangeable sodium percentage, Avl. P- Available phosphorus, Av. K- Available potassium.

Table 3. Selected Physicochemical Properties of the Topsoil (0-30 cm) before planting

Texture (%)				pH (H_2O)	EC (dS/m)	N (%)	OC (%)	C/N	Exchangeable bases cmol(+) Kg^{-1}					EA cmol(+) Kg^{-1}	Avl.P (mg/kg)	Av.K cmol (+) Kg^{-1}
Sand	Silt	clay	Class						Na	K	Ca	Mg	CEC			
24	40	36	CL	6.0	0.09	0.26	1.6	6.14	0.3	0.84	12.8	1.7	22.6	0.07	65	1.0

Table 4. Description of the Soil Profile

Date 05/09/2005

Research Centre: Areka Agricultural Research Centre

Location: 2 kms to South of Angacha town, N7° 03' 043", E38° 29' 407"
Author: Abay Ayalew
Slope(%):6%
Elevation (m asl): 2381
Surrounding landform: plain
Physiographic position: Lower part
Micro topography: No micro relief
Land use/cover: Barley, Beans, Peas, Potato, and Wheat
Parent Material: Basalt
Moisture condition: Moist
Drainage: well drained
Permeability: permeable
Erosion: a) at site: None
b) Surrounding: none

Horizon Description

A 0 - 69 cm light reddish brown (5YR 6/3) dry and dark reddish brown (5YR 3/2) moist; clay loam; angular blocky; slightly hard, friable, slightly sticky - very plastic; many fine to medium pores; very few very fine roots; clear weavy boundary.

Bt_1 69 - 96 cm pinkish gray (5YR 6/2) dry and dark reddish brown (5YR 3/2) moist; clay loam; angular blocky; slightly hard, friable, slightly sticky - very plastic; many fine to medium pores; clear weavy boundary.

Bt_2 96 - 150+ cm Pinkish gray (5YR 7/2) dry and dark reddish gray (5YR 4/2) moist; abundant coarse prominent black mottles; clay loam; angular blocky; slightly hard, friable, sticky - very plastic; many fine to medium pores.

Table 5. Climatic Data of Angacha

a) Mean monthly rainfall (mm)

Year	Jan.	Feb.	Mar	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1995	0.0	82.4	150.2	427.2	84.0	na	265.6	303.6	125.2	3.8	7.5	66.6	1516.1
1996	69.5	na	169.4	268.8	216.4	na	80.0	202.3	189.2	21.0	55.9	0.0	1272.5
1997	0.0	5.5	90.8	282.4	162.9	84.5	64.2	181.1	161.9	263.4	165.3	41.3	1503.3
1998	92.5	60.9	118.9	161.1	181.2	162.2	131.2	143.7	111.5	176.5	41.4	0.0	1345.1
1999	56.3	na	10.8	51.9	135.5	na	na	na	na	236.1	0.0	0.0	490.6
2000	na	na	na	na	na	na	179.3	131.7	142.4	153.5	97.4	41.7	746.0
2001	0.0	2.5	240.2	267.5	201.9	234.0	322.8	175.7	232.8	268.3	443.8	18.1	2407.6
2002	59.3	27.5	84.7	118.2	161.8	203.7	301.7	364.6	279.9	0.0	0.0	67.1	1668.5
2003	20.7	59.0	177.8	286.2	241.1	245.2	266.2	274.1	251.3	40.4	22.0	38.5	1922.5
2004	138	63.5	211.4	218.7	24.0	64.5	236.3	249.6	312.2	152.5	19.0	24.5	1714.2
Mean	48.8	43.04	139.4	231.3	156.5	159.7	205.3	225.2	200.7	131.55	85.23	29.8	1656.1

na - data not available

b) Mean maximum temperature (c^o)

Year	**Jan.**	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Nov.**	**Oct.**	**Dec.**	**Mean**
1995	**25.6**	**25.5**	**25.0**	**25.0**	**24.9**	**na**	**25.2**	**25.2**	**24.7**	**24.5**	**26.0**	**24.7**	**25.12**

1996	**24.4**	**na**	**24.3**	**24.5**	**25.1**	**na**	**24.8**	**24.9**	**25.2**	**24.7**	**24.8**	**24.6**	**24.7**
1997	**24.4**	**24.9**	**24.6**	**24.1**	**24.7**	**24.4**	**24.5**	**23.2**	**24.0**	**24.0**	**24.0**	**25.0**	**24.3**
1998	**24.3**	**23.9**	**24.7**	**24.7**	**24.1**	**24.0**	**23.5**	**23.4**	**23.2**	**23.0**	**23.6**	**23.3**	**23.8**
1999	**23.6**	**na**	**24.4**	**24.3**	**23.9**	**23.3**	**22.7**	**22.8**	**na**	**23.2**	**24.7**	**24.5**	**23.7**
2000	**na**	**na**	**na**	**na**	**na**	**na**	**23.2**	**22.6**	**22.0**	**22.0**	**22.7**	**23.7**	**22.7**
2001	**24.2**	**23.8**	**22.6**	**22.1**	**22.0**	**22.6**	**23.1**	**22.7**	**23.0**	**23.0**	**24.1**	**24.3**	**23.1**
2002	**23.2**	**23.6**	**23.6**	**22.8**	**23.3**	**23.5**	**22.7**	**23.4**	**23.1**	**24.5**	**24.6**	**23.9**	**23.5**
2003	**24.3**	**24.5**	**23.6**	**22.9**	**23.1**	**22.8**	**22.6**	**22.6**	**23.1**	**24.0**	**24.0**	**23.9**	**23.5**
2004	**23.1**	**23.9**	**23.3**	**23.0**	**24.1**	**24.0**	**23.3**	**22.3**	**22.0**	**23.5**	**24.9**	**24.5**	**23.5**
Mean	**24.1**	**24.3**	**24.0**	**23.7**	**23.9**	**23.4**	**23.5**	**23.4**	**23.3**	**23.6**	**24.3**	**24.2**	**23.8**

na - data not available

c) Mean minimum temperature (**c**^{0}**)**

Year	**Jan.**	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Nov.**	**Oct.**	**Dec.**	**Mean**

1995	**16.3**	**15.5**	**14.9**	**15.3**	**15.3**	**na**	**15.2**	**15.7**	**15.4**	**14.3**	**14.6**	**14.7**	**15.2**
1996	**14.4**	**na**	**14.9**	**14.7**	**15.3**	**na**	**15.5**	**14.4**	**14.9**	**15.2**	**14.7**	**15.0**	**14.9**
1997	**15.4**	**15.5**	**15.6**	**15.0**	**15.0**	**13.1**	**12.9**	**11.8**	**11.4**	**11.7**	**12.0**	**13.2**	**13.6**
1998	**12.5**	**12.5**	**12.6**	**12.8**	**13.4**	**12.6**	**12.3**	**12.2**	**12.5**	**12.3**	**13.1**	**na**	**12.6**
1999	**12.2**	**na**	**na**	**13.9**	**13.7**	**13.2**	**12.7**	**12.3**	**na**	**12.3**	**14.3**	**14.6**	**13.1**
2000	**na**	**na**	**na**	**na**	**na**	**na**	**13.3**	**12.4**	**12.0**	**11.8**	**12.9**	**12.7**	**12.5**
2001	**14.2**	**14.3**	**12.4**	**12.3**	**12.7**	**12.2**	**12.8**	**13.2**	**12.9**	**13.1**	**14.8**	**14.0**	**13.2**
2002	**12.9**	**13.9**	**13.5**	**13.2**	**13.7**	**13.5**	**13.1**	**13.4**	**13.1**	**14.7**	**14.7**	**14.0**	**13.6**
2003	**13.8**	**14.1**	**13.4**	**12.9**	**13.0**	**12.8**	**12.6**	**13.1**	**13.6**	**14.6**	**14.0**	**13.2**	**13.4**
2004	**13.0**	**13.5**	**12.5**	**12.9**	**14.0**	**13.6**	**12.6**	**12.0**	**12.0**	**13.5**	**14.6**	**14.4**	**13.2**
Mean	**13.7**	**14.2**	**13.7**	**13.7**	**14.1**	**13.0**	**13.3**	**13.0**	**13.1**	**13.4**	**14.0**	**14.0**	**13.6**

na - data not available