THE WATER OF THE AWASH RIVER BASIN A FUTURE CHALLENGE TO ETHIOPIA

Girma Taddese[1] , Kai Sonder[2] & [3] Don Peden
[1]g.taddesse@cgiar.org ,/girma55@yaoo.com ,
[2] s.kai@cgiar.org & d.peden@cgiar.org

ILRI

P.O.Box 5689 Addis Ababa Ethiopia

Summary

The Awash River Basin faces landdegradation, high population density, natural water degradation salinity and wetland degradation. Already desertification has started at lower Awash River Basin. In the high land part deforestation and sedimentation has increased in the past three decades. As more water is drawn from the river there could be drastic climate and ecological changes which endanger the basin habitat and h uman livelihood. Draining the wetlands for irrigation could imbalance the sustainability of the basin.

Introduction

Over View

Currently Ethiopia's agriculture depends on rainfall with limited use of water resources for irrigation. At approximately 50% of the GDP, agriculture, most of it based on rain-fed small -holder systems and livestock, contributes by far the largest part of the economy and is currently growing on average 5% per year. Highly variable rainfall, frequent floods and droughts, and limited storage capacity continue to constrain the ability of the country to produce reliable food supplies in spite of being relatively rich in water and land resources. Ethiopia has an estimated 3.7 million hectares of irrigable land, yet only about 200,000 hectares (5.4%) is presently irrigated and only provides approximately 3% of the country's food crop requirements. Despite this, the country could still face more than 6 million tons of cereal deficits by the year 2016 (UK Trade and Investment 2004). High population pressure decline of land holding per household, low production and income, abandoning of fallow practices, loss of soil fertility, and increasing demand for fuel energy and construction, materials deforestation, loss of soil and water resources are a challenge to Ethiopia for the coming years. Ethiopia has several river basins (Figure 1).The draught history in Ethiopia shows that draught occurrences vary from year to year (Figure 2). Much of the water resources in Ethiopia are not utilized to meet the food demand(Table 1).

Fig.1 The main river basins in Ethiopia.

It is a dilemma why Ethiopia is starving while it has huge amount of surface water and perennial rivers. It appeared that in the past Ethiopia was only utilizing the Awash River Basin for irrigation development, it accounts for 48% of the national irrigation schemes (FAO, 1995). Thus it is timely to assess the complex situation of the Awash River Basin.

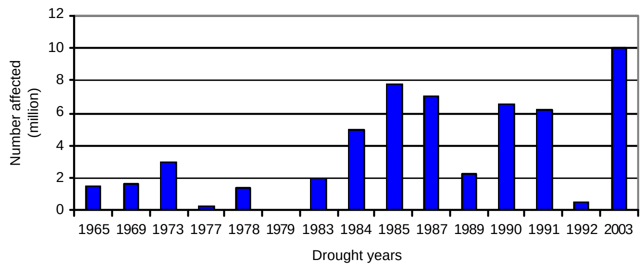

Fig. 2 Drought history in Ethiopia: *Source: Fiona Flintan and Imeru Tamrat, 2002.*

Table 1. Ethiopia's Surface Water Resources by Major River Basins (Mm^3).

No.	River Basin	Catchment Area(Km^2)	Annual Runoff (BM^3)	Specific Discharge ($1/s\,Km^2$)
1	Abbay	199,812	52.6	7.8
2	Awash	112,700	4.6	1.4
3	Baro - Akobo	74,100	23.6	9.7
4	Genale - Dawa	171,050	5.80	1.2
5	Mereb	5,700	0.26	3.2
6	Omo - Gibe	78,200	17.90	6.7
7	Rift Valley	52,740	5.60	3.4
8	Tekeze	89,000	7.63	3.2
9	Wabe Shebele	200,214	3.15	0.5
10	Afar - Danakil	74,000	0.86	-
11	Ogaden	77,100	0	-
12	Aysh	2,200	0	-
	Total	**1,136,816**	**122.0**	

Description of the Basin

The Awash River Basin is the most important river basin in Ethiopia, and covers a total land area of 110,000 km^2 and serves as home to 10.5 million inhabitants. The river rises on the High plateau near Ginchi town west of Addis Ababa in Ethiopia and flows along the rift valley into the Afar triangle, and terminates in salty Lake Abbe on the border with Djibouti, being an endorheic basin. The total length of the main course is some 1,200 km. Based on physical and socio-economic factors the Awash Basin is divided into Upland (all lands above 1500m asl), Upper Valley, Middle (area between 1500m and 1000m asl), Lower Valley (area between 1000m and 500m asl) and Eastern Catchment (closed sub-basin are between 2500m and 1000m asl), and the Upper, Middle and Lower Valley are part of the Great Rift Valleys systems (Figure 3). The lower Awash Valley comprises the deltaic alluvial plains in the Tendaho, Assaita, Dit Behri area and the terminal lakes area. The Rift Valley part of the Awash river basin is seismically active. The international border region of South-Western Djibouti and North-Eastern Ethiopia also named the *Afar Depression* or the *Afar Triangle* or the *Danakil desert*, is a result of the separation of three tectonic plates (Arabian, Somali and African). Shared between Djibouti, Ethiopia and Eritrea, this region is an arid to semi-arid region.

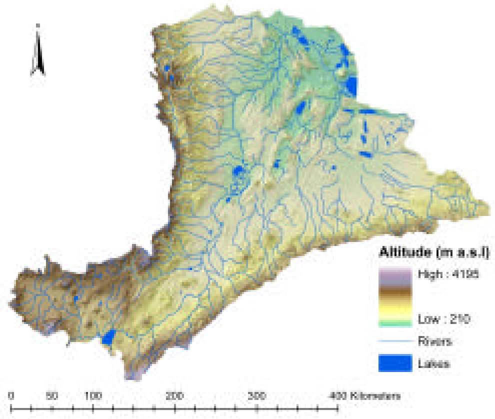

Fig. 3 Elevation map of Awash Basin.

Water resources

In general, plateaus over 2,500m receive 1,400 - 1,800 mm yr^{-1}, mid-altitude regions (600 - 2500m) receive 1 000-1 400mm/year, and lowlands get less than 200 mm yr^{-1}. The rainfall distribution, especially in the highland areas is bimodal, with a short rainy season in March, April and the main rains from June to September (Figure 4). The annual runoff within the basin is estimated at 4.6 km^3 (FAO, 1997). Some tributaries like Mojo, Akaki, Kassam, Kebene and Mile rivers carry water the whole year, while many lowland rivers only function during the rainy seasons. (*http://www.fao.org/docrep/V6718e/v6718E02.htm#2.1.2*).

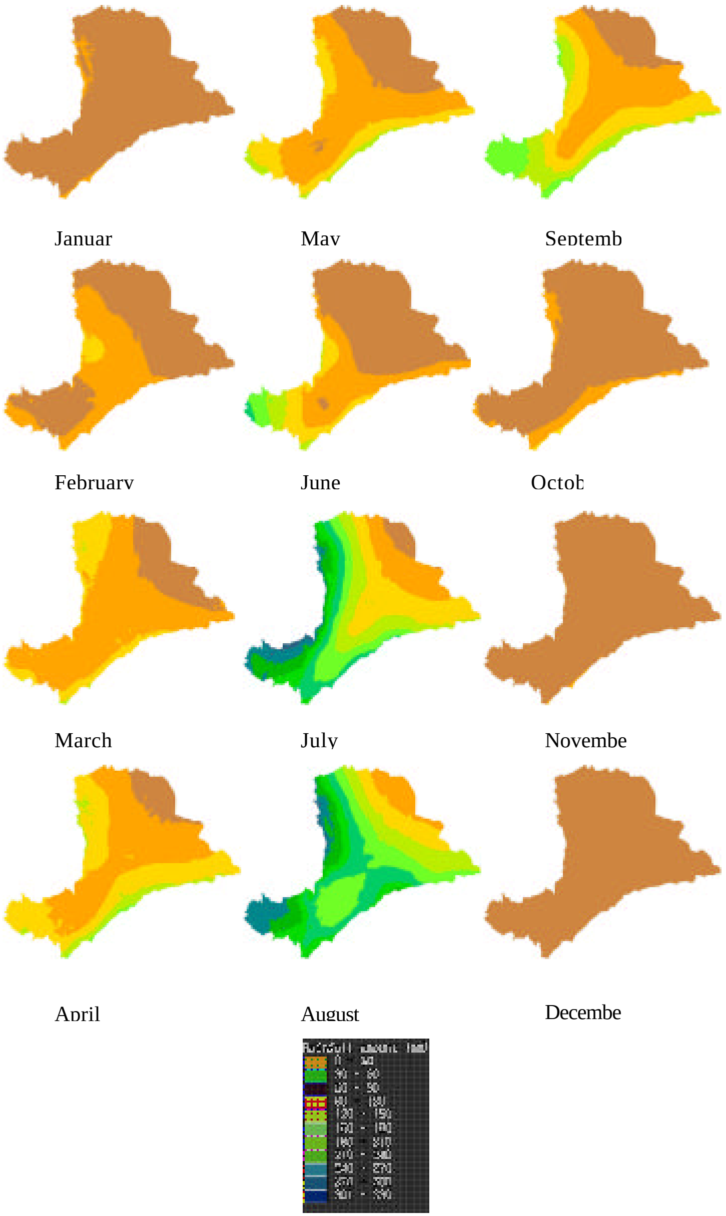

Fig. 4 Monthly rainfall patterns Awash basin(*Data Source: Worldclim 2.0*).

Potential evapotranspiration (PET) in the Upper Valley at Wonji is 1810 mm over twice of the annual rainfall. At Dupti, the lower Valley the mean annual PET is 2348 mm which is over ten times the average annual rainfall. Mean an nual temperatures range from 20.8 ^{o}C to 29 ^{o}C at Koka and at Dupti from 23.8 ^{o}C to 33.6 ^{o}C in June. The mean annual streamflow at Koka is 1.9 m s^{-1} and in Middle Awash Valley exceeds over 2 m s^{-1} in July.

The Awash River Basin is rich in hot springs. There are eight thermal sites near Dubti town which have high perspective for future thermal energy sources. The Koka Dam (11500km^2) was commissioned in 1960, and the mean annual runoff into Koka reservoir amounts 1660Mm^3. At Awash station the annual runoff decreases to 1360 Mm^3 depleted largely by losses from Koka Dam by Upper Valley irrigation diversions (Figure 3). Total mean annual water resources of the Awash River Basin amounts to some 4900 Mm^3 of which some 3850 Mm^3 is currently utilized, the balance being largely lost to Gedebassa Swamp and elsewhere in the river system (Figure 5).

The potential for major ground water development for irrigation is limited in Awash River Basin with the recharge of 14-26%. The ground water flow in the basin from the escarpment is towards north-east to Lake Abe (243 m asl) and to the Danakil depression (-141m bsl). The total ground water recharge is 3800 Mm^3 yr^{-1} (UNDEP 1973). There are numerous springs that feed the ground water with high flow variability 1000 l s-1 in the wet season and less than 10 l/s in the dry season; in the Uplands the depth to the ground varies from 10-250 m, from less than 5 l/s to the high yield of 15-18 l/s. Water quality in the rift valley area of the basin is poor; at Metahara Fluoride concentrations is 21 mg/l. This exceeds the WHO recommendation for fluoride concentration in the order of 1mg/l. In general the ground water quality decreases from the upland to the lower pediment slopes as salinity and fluoride concentration increases.

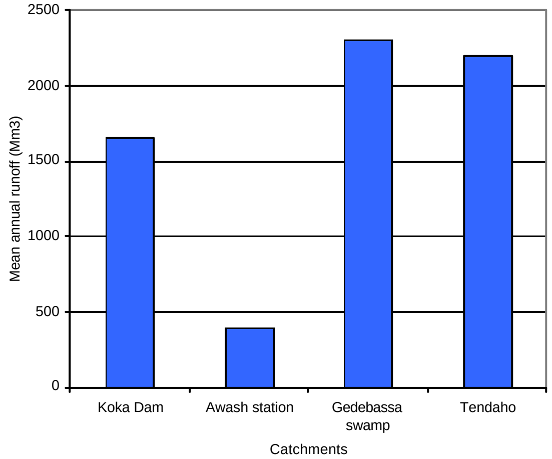

Figure 5. Mean annual runoff (Mm3) at certain catchments of the Awahsh River Basin. Source: EVDSA (1989).

Hydrological balance of Awash River Basin

A delicate hydrological balance characterizes the lower Awash River Basin where, in a normal year, inflows equal losses in lakes and wetlands (Table 1). Below Dupti in Ethiopia, no appreciable runoff from local rainfall reaches the river. The level of Lake Abe thus rises and falls according to the balance between inflow and evaporation losses. The available water from rainfall in the basin is 39,845 ($Mm^3\ yr^{-1}$), 72 % of the rainfall (28383 Mm^3/yr) is lost through evapotranspiration, 18 % (7386 $Mm^3\ yr^{-1}$) runoff and 10% (4074 $Mm^3\ yr^{-1}$) is rechargeable water (EDSA 1989).

Deterioration of Watersheds

As with other parts of Ethiopia, the upper Awash Basin, and its major tributaries have been subjected to major environmental stress. The demand for natural resources by the high and fast growing population remains a major challenge to effective agricultural and forestland management. The high pressure on forest resources in particular, has led to the exploitation of fragile watersheds and ecosystems that have resulted in loss of vegetation and subsequent soil erosion in the lower part of the Awash River Basin (Kinfe 1999).

Socio-economic characteristics and natural resource management

Land use was based on traditional ownership, although all land officially belonged to the governments. The social organization in the Afar region is governed by a customary law and social structure that unites several tribes. Land use is specifically adapted to the size and kind of livestock such as cattle, goats, sheep, and camels; the delineation and non utilization of lands, usually reserved for livestock grazing, for regeneration purposes (Figure 6). Conflict is ongoing in the Awash River Basin, much of which is inter-ethnic and inter-clan in nature (Table 2). Changes to land use had many unwanted impacts, and most of the pastoralists were evicted from the wet grazing lands for dam construction and irrigation development for sugar cane, horticultural crops and cotton (Fiona Flintan and Imeru Tamrat 2002; François Piguet, 2001).

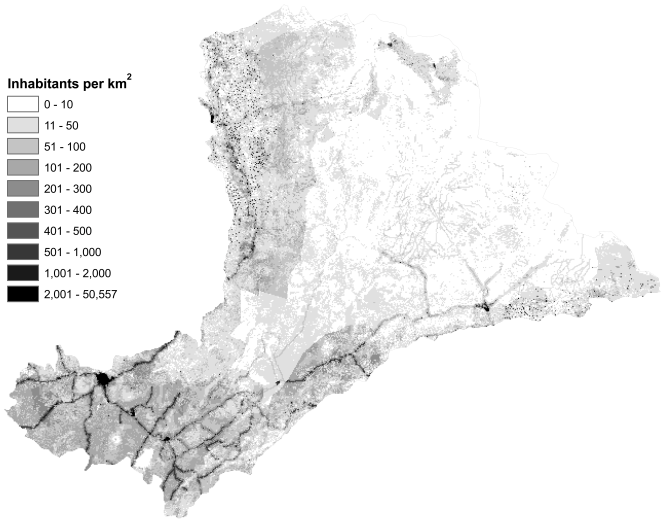

Fig. 6 Population distribution in the Awash Basin *(Source Landscan 2002)*

Table 2. Ethnic groups evicted from Awash River Basin.

Ethnic groupings	Reason for eviction and displacement	Year	Compensation
Jille	Establishment of Dutch HVA and Shoa sugar construction of Koka Dam and creation of Galila Lake. Assignment of land for other urban and rural development projects	1950s 1960s	None
Arsi	Nura Erra irrigation scheme	1950s-1960s	None, some practice pastoralism in hilly Tibila areas
Kerryu	Sugar cane development Metheara Awash National Park	1950s 1966	none
Afar	Commercial Agricultural development	1950s-1960s	Resettlements: Wage labor

Source: *Fiona Flintan and Imeru Tamrat. 2002.*

Water pollution

The Awash River basin and the Rift Valley Lakes basin have special water quality problems to which attention needs to be paid. The Awash River is prone to various types of pollution, with that generated in the urban conglomerate of Addis Ababa and surroundings being most pronounced . Much of the wastewater, both domestic and industrial, produced in that area reaches the Awash river untreated, seriously polluting the water course. Also because downstream the river water is being used for various purposes such as drinking water supply (Nazareth town) and irrigation, public health risks are high.

High fluoride concentration in groundwater in and around the Great Rift Valley is a natural phenomenon having a negative impact on public health. The problem is especially apparent in the Rift Valley Lakes basin and also in the Awash Basin. There is very little capacity for wastewater treatment for Addis Ababa City; therefore, wastewater is discharged directly into the natural watercourses of the Akaki River, which eventually joins the Awash River. The Akaki River is an important water source for small farm operations in and around Addis producing vegetables and livestock fodder; it is one of the tributaries draining Addis Ababa City to the Awash River. Few rigorous investigations have been undertaken, but nitrate levels are reported to be above 10 mg l^{-1} in the surface water, and according to Biru (2002) and Itanna (2002), arsenic (As) and zinc (Zn) are measurably higher in the soils irrigated by the Akai River (Table 3).

Wastewater Reuse

By 2025 urban inhabitants will increase in the Awash Basin. The increase of urban population implies an increase in competing for water. Certain of sources of waste water, like water from urban centers and drainage water from agricultural lands are used for agricultural production. Already municipal waste water and drainage water from Addis Ababa city is extensively used by poor people for vegetable production. However, many believe that waste water has potential risks at present .

A major health concern in much of the middle and some of the lower Awash River Basin is high levels of fluorides in the groundwater, which is used as a major source for drinking water (Gizaw 1996; Tadesse et al., 1998). High concentrations of fluoride occurring naturally in groundwater water are a major source of fluoride intake. It has long been known that excessive fluoride intake carries serious toxic effects. The long-term use of high-fluoride drinking water results in both dental and skeletal fluorosis, which is found in populations in the Middle and Lower Awash, and the Rift Valley Basin.

Table 3. Mean concentration of heavy metals (ppb) and pH in Addis Ababa Catchments.

	Streams	Springs	Boreholes
Heavy metals	Part per billion (ppb)		
pH	7.72	6.61	8.62
Mn	2187.44	29.88	5.14
Cr	4.24	1.84	1.30
Ni	9.03	0.32	0.51
As	1.2	8.44	0.44
Pb	0.00	4.64	16.58
Zn	0.00	3.05	35.25

Source: Tamiru Alemayehu et al., 2003

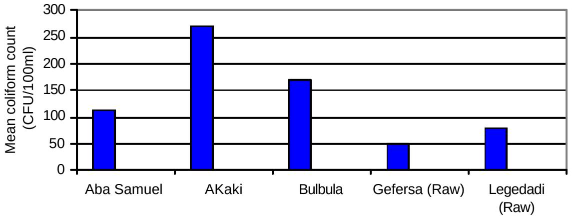

Fig. 7. Mean annual coliform count (CFU/100ml).
Source: Tamiru Alemayehu et al., 2003.

,

Water Borne diseases

In the Awash Valley, *Schistosoma mansoni* is found at the higher altitudes (the upper valley) where the intermediate host, *Biomphalaria pfeifferi* profusely breeds in tertiary and drainage canals of the sugar estates. *Schistosoma haematobium,* causing urinary schistosomiasis, occurs in the middle and lower valley (where average temperatures are higher) where the intermediate snail host *Bulinus abyssinicus* breeds in the clear marshy waters of swamps in undeveloped flood plains. Health records show that before the development of sugar estates, prevalence was limited to the provinces of Harar, Tigray and the Lake Tana Basins of Gojam and Gondar. Agricultural development attracted people from these areas, including people infected with the parasite (Figure 7).
Malaria is a serious problem within the Awash basin, the disease being present in all areas below 2000, frequent epidemics having been reported from areas within the basin (WHO, 2004; Abeku et al., 2003; Abeku et al., 2002) (see Fig 8 , some areas showing no incidence of Malaria in the South Western parts of the basin, between Nazreth and the outskirts of Addis Ababa up to 2000 m).
..

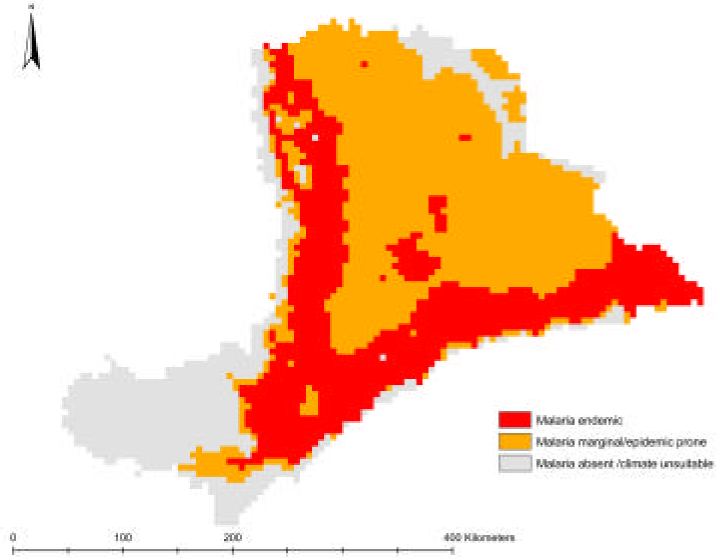

Fig.8 Malaria incidences in Awash basin. Source Lite
(Source: http://www.who.int/docstore/water_sanitation_health/agridev/ch6.htm

Wetland Degradation

Ethiopia adapted, the Awash Basin Surface Water Resources Master Plan, originally adopted in 1989, the plan focusing on management of the upper parts of the watershed, including development of irrigation, hydropower and livestock in the catchments area. Three wetlands were proposed for irrigation development. They are: the Becho Plains, the Gedebassa Swamp and the Borkena Swamp. At present some other small wetlands are being turned to agricultural lands and reservoirs for power generation or irrigation. At a smaller scale, wetlands are being drained resulting in degradation and destruction of the natural ecosystem of the basin. Attempts at draining swamps have not taken into consideration the existing intensive role of the wetlands in providing dry season grazing and other benefits to local communities. In effect the great pluvial lakes in the Afar region are reduced to a few small lakes and swamps, turned into fragile confined ecosystems. The size of Lake Abe has decreased by 67% since the 1930s. For many years, water from the Awash River was used for irrigation. This situation as well as recurrent droughts has contributed to the progressive drying up of the lake exacerbating the situation.

Soil Salinity and Water logging

Salinity problems are recognized throughout the Lower Awash Valley. Another common problem in drained marshes and swamps is that soils become infertile and acid because of oxidation of sulphur and production of sulphuric acid in the drained soils. In poorly drained soils wilt syndrome to cotton is produced under anaerobic condition in the presence of easily oxidizeable-organic matter, presently hydrogen sulphide and reduction of NO^3, Fe, Zn and Cu, this process affects growth of cotton root causing damage and other deformation in plants. Development of large scale irrigation projects without functional drainage system and appropriate water management practices hav e led to gradual rise of saline ground water in the Middle Awash region. In effect, development of persistent shallow saline groundwater, capillary rise due to high evaporation and concentration of the soil solution together with the natural some seeps contributed to secondary salinization (Fentaw Abegaz and Girma Tadesse 1996). Discharge to the groundwater by surplus irrigation water has caused a rise in the water table (0.5

m y r^{-1}) in Middle Awash irrigated field and problems with secondary salinity in surface and sub-surface soil horizons. On the other hand the Awash River salinity increases from Upland to the Lower Valley (Figure 9).

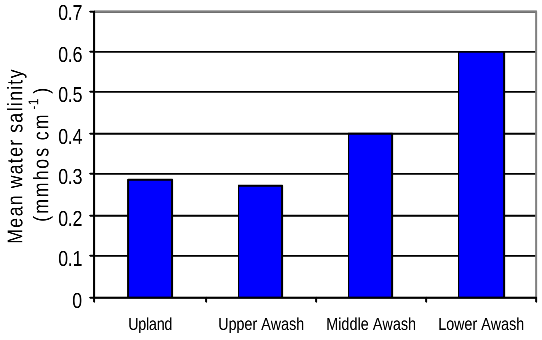

Fig. 9 Mean salinity level of Awash River water (mmhos cm^{-1} *). Source: EVDSA 1989.*

Sedimentation and Erosion

With three generator units installed (Awash I, II and III), the total power generation capacity of Koka dam is 107 MW with an annual power output of 440 GWh. The average annual soil loss in catchments is in the order of 200-300 t/ha or 20,000-30,000 t/km2 (PDRE, 1989). Removal of vegetation cover through deforestation and overgrazing, repeated tilling of the soil to prepare fine seedbed and lack of adequate soil and water conservation is causing the dam to silt up (Figures 10 & 11). Inflow to the reservoir is heavily laden with sediments, and this has lowered the water volume from the designed live storage capacity of 1,667 Mm^3 to 1,186 Mm^3 at present (i.e., loss of 481 Mm^3), which is a loss of 30% of the total storage volume of the reservoir (EEPC, 2002).

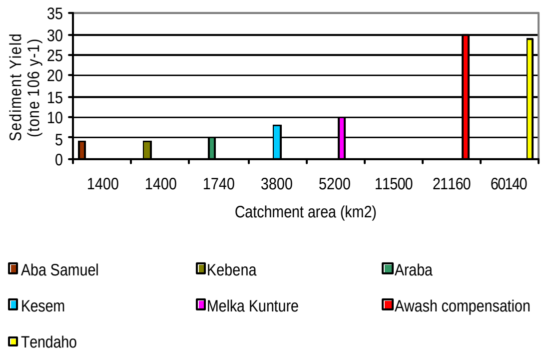

Fig.10 Sediment inflow at main catchments of the Awash River Basin: Source: *EVDSA (1989)*.

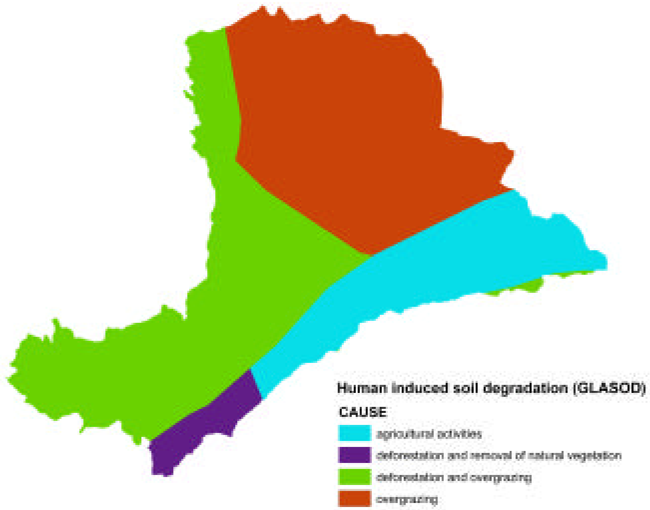

Fig. 11 Human induced soil degradation in the Awash basin (*Source ISRIC, UNEP GRID 1991*).

Irrigation Development

Most of the irrigation schemes in Awash Basin have good reputation in irrigation efficiency which varies from 30 to 55 %. In the early 50's the Koka Dam was built in the basin, which served for hydro-electrical generation and irrigation development in the down stream. Soon after the first sugar factory was established in the basin. Large-scale irrigated farming is common on the floodplain. State farms control some 80% of the irrigated area and smallholder farmers farm the remaining 20% (Table 4). Of the state farm area 92% is grown with cotton, 3% with bananas and 5% with cereals and vegetables.

Table 4 . Existing and potential large scale irrigation in Awash River Basin.

Location	Existing (ha)	New expansion (ha)	Total (ha)
Upper Valley	23300	10600	33900
Middle Valley	19900	35100	55000
Lower Valley	25600	36900	62500
Total	68800	82600	151400

Source: Fiona Flintan and Imeru Tamrat. 2002.

Flooding

The Awash River basin frequently floods in August/September following heavy rains in the eastern highland and escarpment areas. A number of tributary rivers draining the highlands eastwards can increase the water level of the Awash River in a short period of time and cause flooding in the low-lying alluvial plains along the river course. Certain areas which frequently, almost seasonally, get inundated are marshlands such as the area between the towns of Debel and Gewane in the vicinity of Lake Yardi and the lower plains around Dubti down to Lake Abe. The third area which often floods is, about 30kilometres north of Awash town in the vicinity of Melka Werer (see map in annex for geographical location of mentioned places visited). Flooding along Awash River was mainly caused by heavy rainfall in the eastern highlands and escarpment areas of North Shewa and Welo and not because of heavy rain in the upper watershed areas (i.e. upstream of the Koka Reservoir). Over the years soil and water run-off in the escarpment areas have steadily increased as a result of deforestation, the most serious environmental degradation in the escarpment areas being caused by overpopulation in the highlands (Figure 6). Tributaries to Awash river such as Kessem, Kebena, Hawadi, Ataye Jara, Mille and Loqiya rivers contributed most to the lowland flooding in Afar. *(http://www.ocha-eth.org/Archive/DownloadableReports/awash0999.doc).*

Ecosystems and biodiversity in the basin

Vegetation

The Upper Basin Rained area is used by pastoralists during the rainy season because of the higher rainfall and there crop utilization is high (Figure 12).

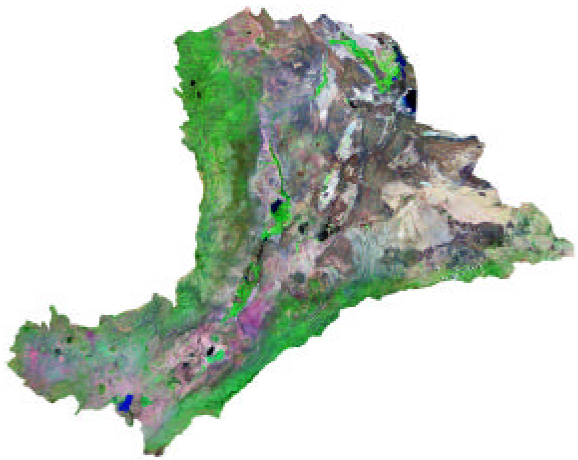

Fig. 12 Landsat 7 Mosaic of Awash basin in 2000 *(Source: GLCF, University of Maryland, NASA Geocover)*.

The dominant vegetation in the Upper and Middle Valley is grassland with some scrubland and riparian forest along the Awash River. The best wet season grazing areas here are the Alidge, Gewane, Awash and Amibar.Some of the plant species include *Balanites aegypticus, Salix subserata, Flueggia virosa, Carissa edulis, Rumex nervosus, Tamarindus indica, Ulcea schimperi* and *Acacia spp.*.
Lasiurus scindicus, *Panicum turgidum* (highly palatable), in the plains of Gobbad and Hanle, associated with *Acacia tortilis*, *Acacia asak* (mainly present in the wadis), *Cadaba rotundifolia* and *Salvadora persica* .*Sporobolus spicatus*, which is typical of saline depressions and swamps, bears signs of some degradation. *Hyphaene thebaica* (Doum palm) formations are characteristic but strongly degraded over the area. Lake Abe is a large (180 km_), shallow and saline (170 g /l NaCl) lake, shared between Djibouti and Ethiopia. It is characterized by sulphur emanations, quicksand, hot springs and hydrothermal travertine rock deposits aligned along faults (Figure 13 *see Appendix A for detail*). The vegetations vary with agroecological zones (Figure 14).

.

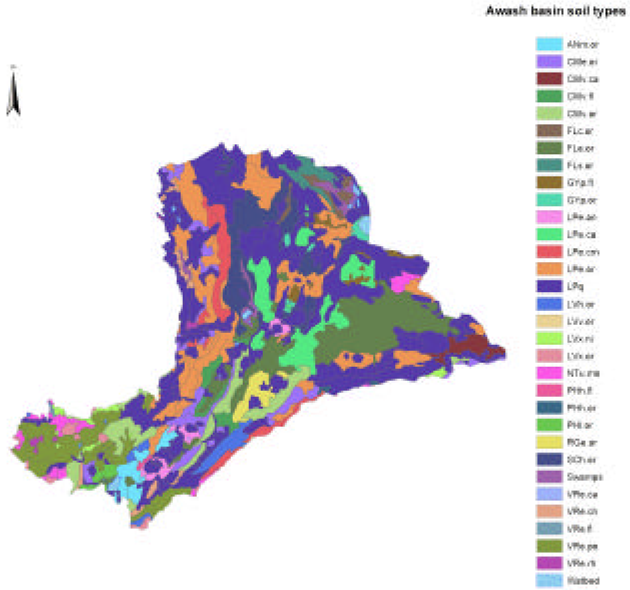

Fig .13 Major soil types inthe Awash basin *(Source FAO, 1996)*.

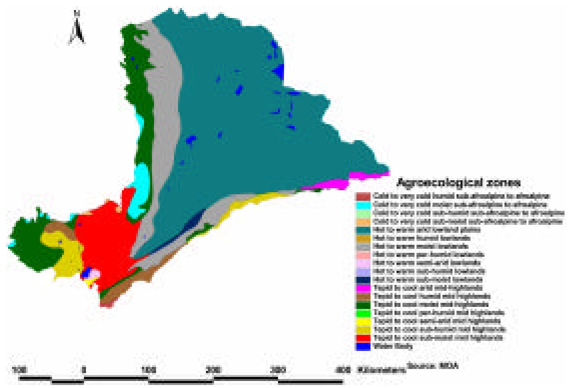

Fig. 14 Agroecological zones in the Awash Basin *(Source MOA, 2002)*.

Animal diversity

The wild ass lives in open desert country and in lava-strewn hills among the rocks and cliffs, across the plains of the Danakil region and the Awash Valley. The Somali wild ass (*Equus asinus somalicus)* is of global significance as it is the only existing representative of the African wild ass with only a few hundred individuals left.
(http://www.stlzoo.org/animals/abouttheanimals/mammals/hoofedmammals/somaliwildass.htm)

Awash National Park is the oldest and most developed wildlife reserve in Ethiopia. Featuring the 1,800-metre Fantalle Volcano, extensive mineral hot-springs and extraordinary volcanic formations, this natural treasure is bordered to the south by the Awash River and lies 225 kilometers east of the capital,
The wildlife consists mainly of East African plains animals, but there are now no giraffe or buffalo , Oryx, bat-eared fox, caracal, aardvark, colobus and green monkeys, Anubis and Hamadryas baboons, klipspringer, leopard, bushbuck, hippopotamus, Soemmering's gazelle, cheetah, lion, kudu and 450 species of bird all live within the park's 720 square kilometers.
Awash National Park. 2004. Selemeta. http://www.selamta.net/national_parks.htm

Hydropower on the Awash River Basin

Though Ethiopia has substantial hydropower potential it has one of the lowest levels of per capita electrical consumption in the world. There are three functional dams in Awash River Basin, Aba Samuel (1.5 GWh/year) commissioned in 1939, Koka (110 GWh/year) commissioned in 1960, Awash II (165 GWh/year) commissioned in 1966, and Awash III (165 GWh/year) commissioned in 1971. Koka was built on the upper Awash for hydropower generation and irrigation development downstream. The dam has served for four decades. In the coming years five additional dams are proposed to be built for hydropower generation and irrigation development in the basin.

Environmental and Social Aspects

This presents a significant health hazard from the microbiological contamination to the surface and groundwater, and concerns that heavy metals are accumulating soils. Few rigorous investigations have been undertaken, but nitrate levels are reported to be above 10 mg/l in the surface water, and according to Biru (2002) and Itanna (2002), arsenic (As) and zinc (Zn) are measurably higher in the soils irrigated by the Akai River. Akaki River is one of the tributaries draining Addis Ababa City to the Awash River. In the middle and lower Awash the water -related health hazards are malaria and schistosomiasis, which are reported to be increasing in prevalence and severity. Basic requirements such as water supply, sanitation and health facilities are poor (Waltainformation 2004).

The single overriding factor in the ecology of the Awash Basin is the rapid and continuous increase in population and the adverse effects on the resources of the basin, in particular, on the rapid erosion and degradation of the upland soils. The high indication of the sediment load is a result of deforestation and less ground cover in the highland of the upper basin.

Desertification

Figure 1 5. Desertification in Lower Awash Basin, July 2002, *Courtesy Girma Taddese* .

Manifestations of desertification in Awash River Basin include accelerated soil erosion by wind and water, increasing salinization of soils and near-surface groundwater supplies, a reduction in soil moisture retention, an increase in surface runoff and stream flow variability, a reduction in species diversity and plant biomass, and a reduction in the overall productivity in dry land ecosystems with an attendant impoverishment of the human communities dependent on these ecosystems. The lower Awash River Basin is under severe land degradation and desertification (Figure 15). As the few trees are removed for charcoal and fuel wood, salt patches and salt accumulation is appearing over large areas killing the vegetation cover. In both Middle and Lower Awash River Basin Prosopis Juliflora, an aggressive exotic plant species, is spreading at alarming rates in alluvial fertile land, around homesteads, and in drainage canals and roads. Juloflora believed to have allelopathic potential on indigenous vegetation.

Cropping pattern and crop production

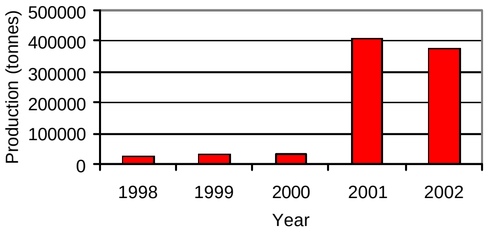

Figure 16 . Horticultural production in Middle Awash River Basin. Source: Ethiopian Horticultural Corporation Share Enterprise *(Annual Report 2003).*

The state farms are generally found in the Middle and Lower sections of the valley and the major irrigators in the upper valley are the Ethiopian Sugar Corporation Ethiopian Share Enterprise (ESC) and Ethiopian Horticultural Corporation Share Enterprise (HDC). Historically sugar and cotton have been the major crops grown in Middle and Lower Awash Valley .Fruit production has been increasing since about 1999, with the bulk of fruit and vegetables sold in the local market in all river Basins in Ethiopia. The production of high value vegetables for export has recently been introduced in the Rift Valley Lake Basin and Awash River basin. In 2001 and 2002 the exported vegetables has increased by 95 % as compared to 1998. Among this 45 % of the flower exported comes from the Awash River Basin (Figure 16). As the external market opportunity is growing several private flower enterprises are emerging. In the lower valley of the drier areas where moisture is critical summer cropping pattern is common such as cotton. However in the Upper Valley the highest percentage of cropping is occupied with sugar cane (Figure 17). Ethiopia is completely self-sufficient in cotton. This crop holds significant opportunities for export. Existing textile industries demand approximately 50,000 tons of lint cotton annually. In addition, there are good prospects for exporting lint (Figure 18). Opportunities for production and processing of cotton in Ethiopia are significant. The prevailing cropping pattern in the upper Valley is sugar cane (74%), in the middle Valley cotton (82%) and in the lower Valley cotton (75%).

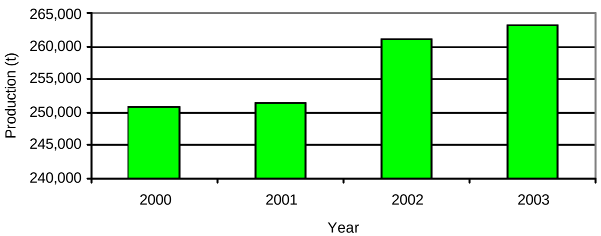

Fig. 17 Sugar production in Awash River Basin. *(Source: Annual report of the Ethiopian Sugar Industry Center Share Company, 2003).*

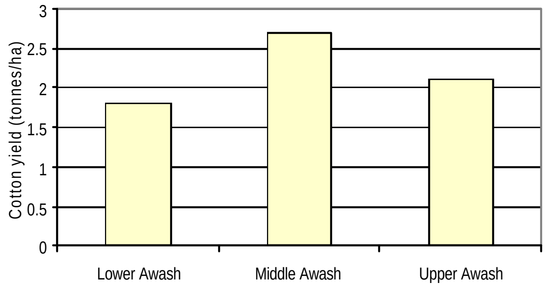

Fig. 18 Mean Cotton Yield in Awash River Basin. *Source: RATES 2004*.

The Middle and Lower Awash is one of the major cotton producing areas of Ethiopia. However, during the last decades most of the agricultural land has been aban doned as a result of inherent soil salinity and saline shallow ground water. In most of the irrigation project development drainage system were not built. Thus the irrigated land did not change over time and expanded, as salinity became a major threat ford evelopment of agricultural land. Cotton produce after ginning is supplied to local textile industries (Figure 18).

Livestock

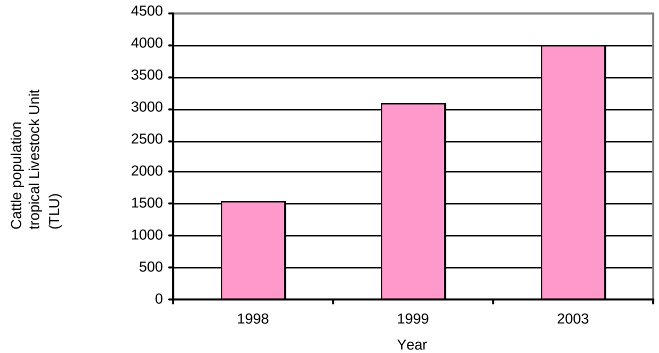

Figure. 19. Cattle population in Middle and Lower Awash Valley (Afar Region).

The Awash valley has historically been a main gateway for the caravan trade between the coast and the highlands of Ethiopia to Djibouti and Berbera. At present, the strategically important official import and export trade activities of the country take place through the pastoral areas of the Afar and Somali regions. Cross-border trade with neighboring countries is also an important aspect of the economic life in these pastoral areas of the country. In 2001, the total population of the Afar region was 1.24 million while that of the Somali region was about 3.9 million. In addition to the large human population, these regions also account for a large number of the livestock population of the country. The Afar region, which is part of Middle and Lower Awash River Basin , has 3.6 million cattle, which is 7.4% of the national total, while the region's sheep and goat populations are 2 million (7.8%) and 3 million (13.8%) respectively. Besides this, the Afar region has 192,872 pack animals, i.e., 3 % of the national total, and 871,832 camels, which is 27 % of the national total (Reporter 2003). The livestock population in Afar Region in Middle and Lower Awash Basin has showed an increasing trend starting from 1998 (Figure 19). This was mainly due to several water points developed in the region, which once was a critical issue in the region. Currently great attention is paid for the pastorals development to increase, feed resources, watering points, health and marketing.

References

Abate, Z. 1994. Water Resources Development in Ethiopia: An Evaluation of present and future planning concepts. Ithaca Press Reading. UK.

Abegaz, F., and G. Tadesse. 1996. Reclamation of salt affected soils in the Middle Awash Region. In: Teshome Yizengaw, Eyasu Mokonnen, and Mintesinot Behailu (eds.). 1996. Proceedings of the third conference of the Ethiopian Society of soil Science, February 28-29, 1996. Addis Ababa, Ethiopia, 194 pp.
Awash National Park. 2004). Selemeta. *http://www.selamta.net/national_parks.htm*

Biru, A. 2002. Assessment of the fertility and pollution status of irrigated vegetable farms around Addis Ababa City Agricultural Office. Final Report. Addis Ababa, Ethiopia.

Ethiopian Electric Power Corporation (EEPC). 2002. Koka Dam sedimentation study: Recommendations report. Ethiopian Electric Power Corporation. June 2002, Addis Ababa. EEPC, 2002. Koka Dam sedimentation study: Recommendations report. Ethiopian Electric Power Corporation. June 2002, Addis Ababa.

Ethiopian Horticultural Corporation Share Enterprise (EHCSE). 2003. Annual Report.

Gizaw, B. 1996. The origin of high bicarbonate and fluoride concentrations in waters of the Main Ethiopian Rift Valley, East African Rift System. Journal of African Earth Sciences, 22, 391-402. http://www.ethiopianreporter.com/eng_newspaper/Htm/No342/r342eco1.htm

Itanna, F. 2002. Metals in leafy vegetables grown in Addis Ababa and toxicological implications. Ethiopian Journal of Health and Development. 16 (3): 295-302.

Kinfe, H. 1 999. Impact of climate change on the water resources of Awash River Basin, Ethiopia. Climate Research, Vol. 12, pp. 91-96.

Peoples Democratic Republic of Ethiopia (PDRE). 1989. Master plan for the Development of Surface Water Resources in the Awash Basin. Ethiopian Valleys Development Studies Authority. Final Report, Volume 6. Halcrow.

Regional Agricultural Trade Expansion Support Program (RATES), 2 004. Cotton Textile Apparel Value Chain Report. Agridev Consult.http://www.ratescenter.org/pdf/reports/cotton_eth_038.pdf

Reporter. 2003. Towards transforming the economic role of the pastoral regions in Ethiopia. Media and Communications Center (MCC), Wednesday, March 26,2003.

Sugar Industry Support Center Share Company (SISCSC). 2003. Annual Report.

Tadesse, G., and Bekele, E. 1996.Saline and Saline Sodic soils of the Middle Awash Valley Ethiopia. In: Teshome Yizengaw, Eyasu Mokonnen , and Mintesinot Behailu (eds.). 1996. Proceedings of the third conference of the Ethiopian Society of soil Science, February 28-29, 1996. Addis Ababa, Ethiopia, 194 pp.

Tadesse, G., E. Bekele, G. Eticha and F. Abegaz. 1998. Evaluation of Awash River w ater for irrigation under Middle Awash condition. In: Tadelle G/Sellasie and Sahelemedhin Sertsu (eds.). 1998. Proceedings of the fourth conference of the Ethiopian Society of soil Science, February 26-27, 1998. Addis Ababa, Ethiopia, 150 pp.

UK Trade and Investement 2004. http://www.tradepartners.gov.uk/water/ethiopia/opportunities/opportunities.shtml.

Waltainformation 2004. Vegetables Cultivated Along City's Polluted Rivers Said Posing Danger To Health http://www.waltainfo.com/EnNews/2003/Mar/18Mar03/Mar18e7.htm

Appendix A

FAO, 1998. The soil and terrain database for northeastern Africa. Crop production system zones of the IGAD subregion. FAO, Land and water digital media series 2. Rome, Italy

FAOCLASS

The soil according to the FAO soil classification

Code	Soil unit
FL	FLUVISOLS
FLe	Eutric fluvisols
FLc	Calcaric Fluvisols
FLd	Dystric Fluvisols
FLm	Mollic Fluvisols
FLu	Umbric Fluvisols
FLt	Thionic Fluvisols
FLs	Salic Fluvisols

GL	GLEYSOLS
GLe	Eutric Gleysols
GLk	Calcic Gleysols
GLd	Dystric Gleysols
GLa	Andic Gleysols
GLm	Mollic Gleysols
GLu	Umbric Gleysols
GLt	Thionic Gleysols
GLi	Gelic Gleysols

RG	REGOSOLS
RGe	Eutric Regosols
RGc	Calcaric Regosols
RGy	Gypsic Regosols
RGd	Dystric Regosols
RGu	Umbric Regosols
RGi	Gelic Regosols

LP	LEPTOSOLS
LPe	Eutric Leptosols
LPd	Dystric Leptosols
LPk	Rendzic Leptosols
LPm	Mollic Leptosols
LPu	Umbric Leptosols
LPq	Lithic Leptosols
LPi	Gelic Leptosols

AR	ARENOSOLS
ARh	Haplic Arenosols
ARb	Cambic Arenosols
ARl	Luvic Arenosols
ARo	Ferralic Arenosols
ARa	Albic Arenosols
ARc	Calcaric Arenosols
ARg	Gleyic Arenosols

AN	ANDOSOLS
ANh	Haplic Andosols
ANm	Mollic Andosols
ANu	Umbric Andosols
ANz	Vitric Andosols
ANg	Gleyic Andosols
ANi	Gelic Andosols

VR	VERTISOLS
VRe	Eutric Vertisols
VRd	Dystric Vertisols
VRk	Calcic Vertisols
VRy	Gypsic Vertisols

CM	CAMBISOLS
CMe	Eutric Cambisols
CMd	Dystric Cambisols
CMu	Humic Cambisols
CMc	Calcaric Cambisols
CMx	Chromic Cambisols
CMv	Vertic Cambisols
CMo	Ferralic Cambisols
CMg	Gleyic Cambisols
CMi	Gelic Cambisols

CL	CALCISOLS
CLh	Haplic Calcisols
CLl	Luvic Calcisols
CLp	Petric Calcisols

GY	GYPSISOLS
GYh	Haplic Gypsisols
GYk	Calcic Gypsisols
GYl	Luvic Gypsisols
GYp	Petric Gypsisols

SN	SOLONETZ
SNh	Haplic Solonetz
SNm	Mollic Solonetz
SNk	Calcic Solonetz
SNy	Gypsic Solonetz
SNj	Stagnic Solonetz
SNg	Gleyic Solonetz

SC	SOLONCHAKS
SCh	Haplic Solonchaks
SCm	Mollic Solonchaks
SCk	Calcic Solonchaks
SCy	Gypsic Solonchaks
SCn	Sodic Solonchaks
SCg	Gleyic Solonchaks
SCi	Gelic Solonchaks

KS	KASTANOZEMS
KSh	Haplic Kastanozems
KSl	Luvic Kastanozems
KSk	Calcic Kastanozems
KSy	Gypsic Kastanozems

CH	CHERNOZEMS
CHh	Haplic Chernozems
CHk	Calcic Chernozems
CHl	Luvic Chernozems
CHw	Glossic Chernozems
CHg	Gleyic Chernozems

PH	PHAEOZEMS
PHh	Haplic Phaeozems
PHc	Calcaric Phaeozems
PHl	Luvic Phaeozems
PHj	Stagnic Phaeozems
PHg	Gleyic Phaeozems

GR	GREYZEMS
GRh	Haplic Greyzems
GRg	Gleyic Greyzems

LV	LUVISOLS
LVh	Haplic Luvisols
LVf	Ferric Luvisols
LVx	Chromic Luvisols
LVk	Calcic Luvisols
LVv	Vertic Luvisols
LVa	Albic Luvisols
LVj	Stagnic Luvisols
LVg	Gleyic Luvisols

PL	PLANOSOLS
PLe	Eutric Planosols
PLd	Dystric Planosols
PLm	Mollic Planosols
PLu	Umbric Planosols
PLi	Gelic Planosols

PD	PODZOLUVISOLS
PDe	Eutric Podzoluvisols
PDd	Dystric Podzoluvisols
PDj	Stagnic Podzoluvisols
PDg	Gleyic Podzoluvisols
PDi	Gelic Podzoluvisols

PZ	PODZOLS
PZh	Haplic Podzols
PZb	Cambic Podzols
PZf	Ferric Podzols
PZc	Carbic Podzols
PZg	Gleyic Podzols
PZi	Gelic Podzols

LX	LIXISOLS
LXh	Haplic Lixisols
LXf	Ferric Lixisols
LXp	Plinthic Lixisols
LXa	Albic Lixisols
LXj	Stagnic Lixisols
LXg	Gleyic Lixisols

AC	ACRISOLS
ACh	Haplic Acrisols
ACf	Ferric Acrisols
ACu	Humic Acrisols
ACp	Plinthic Acrisols
ACg	Gleyic Acrisols

AL	ALISOLS
ALh	Haplic Alisols
ALf	Ferric Alisols
ALu	Humic Alisols
ALp	Plinthic Alisols
ALj	Stagnic Alisols
ALg	Gleyic Alisols

NT	NITOSOLS
NTh	Haplic Nitosols
NTr	Rhodic Nitosols
NTu	Humic Nitosols

FR	FERRALSOLS
FRh	Haplic Ferralsols
FRx	Xanthic Ferralsols
FRr	Rhodic Ferralsols
FRu	Humic Ferralsols
FRg	Geric Ferralsols
FRp	Plinthic Ferralsols

PT	PLINTHOSOLS
PTe	Eutric Plinthosols
PTd	Dystric Plinthosols
PTu	Humic Plinthosols
PTa	Albic Plinthosols

HS	HISTOSOLS
HSl	Folic Histosols
HSs	Terric Histosols
HSf	Fibric Histosols
HSt	Thionic Histosols
HSi	Gelic Histosols

AT	ANTHROSOLS
ATa	Aric Anthrosols
ATc	Cumulic Anthrosols
ATf	Fimic Anthrosols
ATu	Urbic Anthrosols

List of third level subunit names

Code	*Name*	*Description*
.al	albic	Albi-soils having an albic E horizon
.an	andic	Andi-soils having andic properties
.ar	arenic	Areni - intergrade to Arenosols
.ca	calcaric	Calcari-soils which are calcareous within 125 cm of the surface
.ch	chromic	Chromi - Vertisols having a moist value of more than 3 and a chroma of more than 2 dominant in the soil matrix throughout upper 30 cm.
.cm	cambic	Having a cambic horizon
.dy	dystric	Dystri-soils having a base saturation of less than 50% (by NH4OAc) in some parts within 125 cm of the surface
.eu	eutric	Eutri-soils having a base saturation of 50% (by NH4OAc) to a depth of 125 cm from the surface
.fe	ferric	Ferri-soils having ferric properties within 100 cm of the surface
.fl	fluvic	Fluvi - soils developed from alluvial deposits
.gl	gleyic	Gleyi - intergrade to Gleysols
.ka	calcic	Calci-soils having a calcic horizon or concentrations of soft powdery lime within 125 cm of the surface
.lu	luvic	Luvi-soils having an argic horizon
.ma	mazzic	Mazi-Vertisols having a massive structure in the upper 30 cm and becoming hard when dry
.mo	mollic	Molli-soils having a mollic horizon
.ni	nitic	particularly Acrisols having nitic properties
.or	orthic	Orthi-soils, having no specific characteristics to separate them at third level
.pe	pellic	Pelli-Vertisols having a moist value of 3 or less and a crhoma of 2 or less dominant in the soil matrix throughout the upper 30 cm
.pl	plinthic	Plinthi-soils, having plinthite within 100 cm of the surface
.rh	rhodic	Rhodi-soils having a red to dusky red B horizon (rubbed soils have hues redder that 5YR with a moist value of less than 4 and a dry value not more than one unit higher than the moist value
.ro	yermic	Yermi-soils such as Regosols and Arenosols showing yermic properties
.sm	sombric	Sombri - applies to Ferralsols showing some accumulation of dark colour organic matter in the ferralic B horizon
.um	umbric	Having an umbric horizon
.ve	vertic	Verti - intergrade to Vertisols