SOCIO-ECONOMIC IMPACTS OF FLOODING IN DIRE DAWA, ETHIOPIA

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ABSTRACT

Dire Dawa, the second largest city of Ethiopia, has been suffering from disastrous floods in its history. The flooding of 6 August, 2006 was unprecedented and caused severe impacts in the city. This study focused on finding out flood causative factors and the impacts of flooding on the socio-economic sectors of Dire Dawa. To achieve the objectives the study employed trend analysis; soil conservation service curve number method (SCS-CN); Inundation analysis and ECLAC methodology. Results of the analysis showed that high intensity of rainfall accompanied by severe forest degradation has caused increased flood damage in the impact area. Moreover, the inundation result showed residential areas and business centers experienced the worst socio-economic damages among the different sectors in the city. It has also an enormous impact on the economic foundation of the city due to expenditure for rehabilitation and reconstruction. Absence of early warning system and land-use policy has contributed to the increased impact of the disaster.

Key words; Dire Dawa, Flood, Rainfall intensity, forest degradation, early warning system

INTRODUCTION

Dire Dawa, which was established in 1910 and located at the foot hills of eastern *Harerge* highlands, has been repeatedly hit by powerful flood disasters. Floods at different time have destroyed homes, public institutions, market places with their properties, infrastructures, crops in the field, livestock. In Dire Dawa, flood in August 1981 which killed about 80 people was previously considered as the worst in the town's history. However, the unprecedented August 6, 2006 flooding was worst of all cases; it surpassed all flood disasters that occurred in the past in loss of human life, and property damages.

OBJECTIVES

- ✧ To identify and assess the major flood-triggering factors in the Dechatu catchment
- ✧ To generate maps of flood inundation in Dire Dawa by using data from peak runoff events.
- ✧ To carry out a socio – economic impact survey and examine the extent of the disaster in individual and public property by using ECLAC method of disaster impact calculation.
- ✧ To generate policy relevant recommendations

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General description of the study area

Location

Dire Dawa city is located in the eastern part of Ethiopia between $9^0$27'N and $9^0$49'N latitude and $41^0$38`Eand $42^0$19`E longitude, and in the eastern marginal catchment of Awash basin (Fig 1). East *Hararge* Administrative zone of *Oromiya* Regional State borders it in the south and southeast and *Shinele* zone of Somalia Regional State in the north, east and west. Dire Dawa city is accessible by air, railway and road, and is about 500 kms road distance to the east of Addis Ababa and 311kms to the west of Djibouti port.

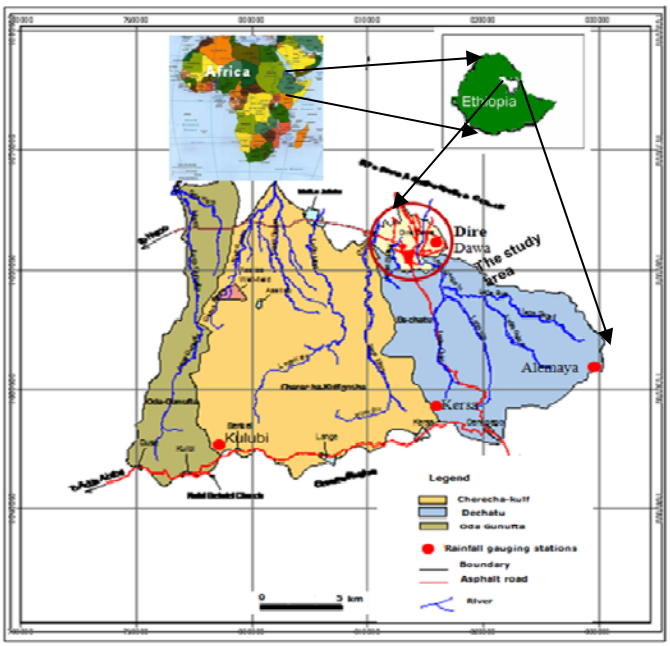

Fig.1 Study area location

METHODOLOGY

- **Trend analysis is employed to examine the trend of rainfall in the catchment**
- **Estimation of discharge data of the Dechatu River using SCS-CN method**

As no runoff data are available for Dechatu River, the Curve Number (CN) Method has been used to derive flood discharges from the rainfall data.

Hence, the peak discharge for the catchment can be calculated as,

$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$

$S = \frac{1000}{89} - 10 = 31.5\text{mm}$

$$Q = \frac{(166 - 0.2 * 31.5)2}{(166 + 0.8 * 31.5)}$$

Q=133.39mm

Where q_p=peak runoff (in cfs)

q_u=unit peak discharge (csm/in)

A_m= drainage area (mi^2)

Q= Rainfall excess (in)

F_p= pond and swamp adjustment factor

$q_p = q_u A_m Q F_p$ (USDA, 1986)

q_u=200(csm/in); A_m=55.mi^2; Q=5(in)

F_p=0.89

q_p= 200*55.5*5*0.89

q_p= 49395(cfs)= 1400m^3/s

- **Inundation Analysis**

In this study, Arc GIS 9.1 and HEC-RAS 3.1.3 have been used. HEC-RAS have been used to acquire cross-sections from DEM, to interpolate flood water levels between sections, to compute flood depth from DEM and finally flow simulation is performed and the result is exported to GIS to process the inundation map. In the Arc GIS the imported map is converted into xml file and layer is setup. Then Water surface TIN is generated. Finally, flood plain delineation is performed to calculate the flood plain boundary and inundation depth and create the inundation map.

- **Economic Commission for Latin America and Caribbean (ECLAC) method**

The Economic Commission for Latin America and the Caribbean (ECLAC) method is a tool to quantify the social, economic and environmental impacts of disaster. Based on special disaster assessment endeavors in Latin America and Caribbean region since the early 1970s, ECLAC developed an assessment methodology (ECLAC, 2003). In this study ECLAC methodology is employed to assess the direct and indirect impacts of the 2006 flooding on different economic sectors and to identify the most affected sector as well as the secondary effects of the disaster.

RESULT AND DISCUSSION

FLOOD CAUSATIVE FACTORS IN DECHATU CATCHMENT

I *Rainfall in the upland areas of Dechatu catchment*

The rainfall in all upland stations from 1995-2006 has shown decreasing trend (Fig.2). The decreasing trend of annual rainfall can be associated to the global climate change which also affects the climate of Ethiopia. Also UNDP (2007), find out that a recent trend of Ethiopian rainfall indicates a decreasing tendency in the annual rainfall in some areas.

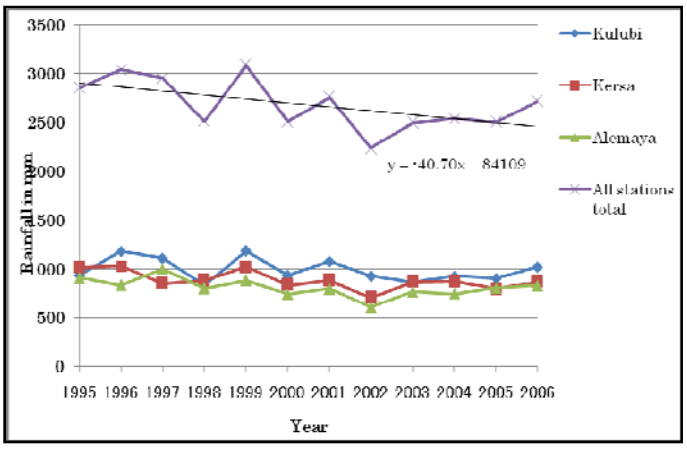

Fig. 2 Rainfall trend in upland stations of Dechatu catchment

***Note**: The line graph referring to ''all stations total'' is the sum of the total amount of rain that was recorded in each of the three upland stations from 1995 to 2006*

Although the rainfall has shown a decreasing trend, rainfall concentration in some months such as August is high. For instance in 2006 rainfall is largely concentrated during the month of August

(Fig.3) and its intense occurrence has caused worst flooding in downstream area (Table 1).

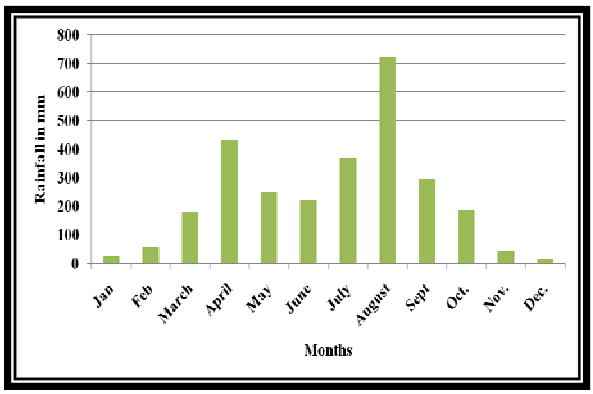

Fig.3 Monthly rainfall distribution in the upland Station (*Alemaya*, *Kersa*, and *Kulubi*) in 2006.

Table 1 Rainfall measured in upland stations

Date Aug. 2006	Dire Dawa	Kersa	Alemaya	Kulubi	Total
1	0	0	0	0	0
2	0	0	0	0	0
3	4.3	7.9	18.9	26.7	57.8
4	10.2	0	24.5	4.7	39.4
5	36.9	16 6	118	100	420.9
6	1	0	7.3	0	8.3

Note: the rainfall in August 5, 2006 in all upland areas was unusually heavy and intense that caused flooding in Dire Dawa. 67% in Kersa, 48% in Kulubi, 43% in Alemaya, and 26% in Dire Dawa of the monthly total rain fall a single day, in August 5.

II ***Land-use change in Dechatu catchment***

In Ethiopia due to absence of land-use policy forest resources are utilized in abusive way.

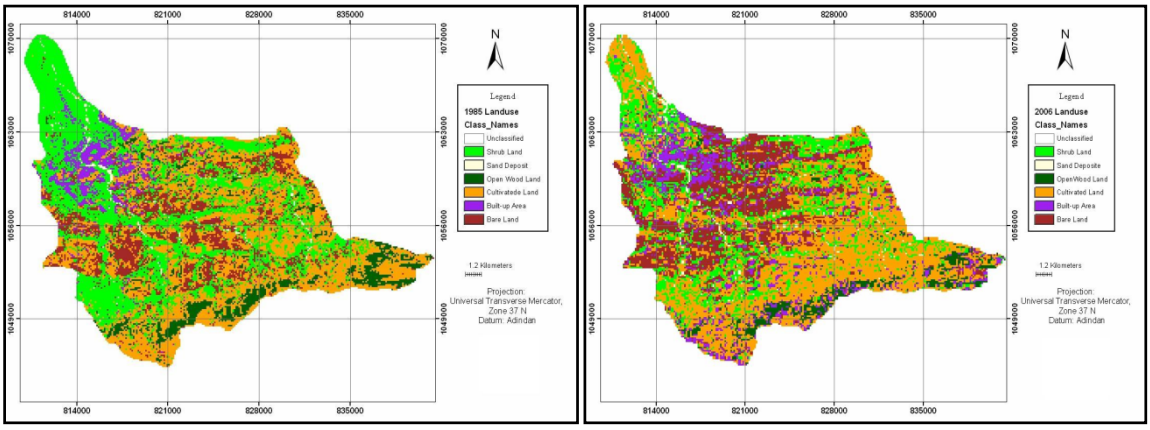

Fig 4 Land-use change map of Dechatu catchment, the years 1985 and 2006.

Referring to the 1985 and 2006 land-use map of Dechatu catchment farmland and urbanized areas are increased from 11.04% to 12.77% and from 39% to 56.33% respectively. This increase is in the expense of forestland that reduced from 18.14% to 4.19% during the same period (1985 to

2006) (Fig.4). Forestland degradation has directly correlated to surface runoff generation and increased occurrence of flooding in Dire Dawa. In this regard Calder (1999) figured out a rate of 300-800mm reduction in annual stream flow after afforestation took place in Transvaal region of South Africa. Ethiopia lacks comprehensive land-use policy that gave way to severe forest resource degradation and this in turn aggravated flooding. Similarly Bishaw (2001) pointed out that the major forestry problems in Ethiopia is absence of sound and comprehensive land-use policy.

INUNDATION AREAS OF DIRE DAWA CITY

Based on the result of the inundation analysis (Fig. 5), in the residential areas 55.9% of the total inundation area is covered by 1m inundation depth; 30% of the total inundated area is covered by 2m inundation depth. Generally, about 86% of the total inundated area is covered by 1 to 2m inundation depth. Since all of the houses in the inundated area are one storey houses, this depth of inundation could cause damage of houses and property; and cause human casualty.

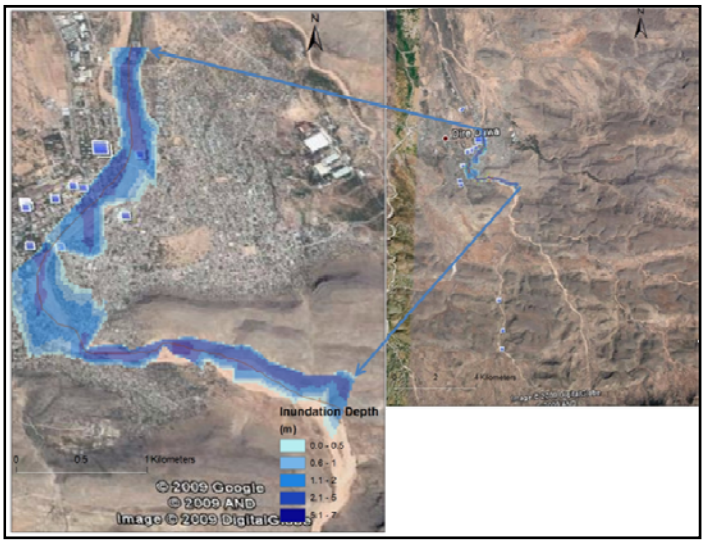

Fig. 5 Inundation map of Dechatu catchment

Note: The inundation map prepared from GIS tool is overlaid on Google map to show the inundation area of the city.

SOCIO-ECONOMIC IMPACTS OF FLOODING IN DIRE DAWA

The 2006 flood has inflicted severe direct and indirect damages on social; infrastructure and economic sectors of Dire Dawa. It caused the death of 256 people, 244 missing and 15,000 people displaced from their dwellings. Number of fatalities was large because floods hit the city in the middle of the night while people were in deep sleep and absence of early warning system that alerts the residents before the flood hit the city. Of the total fatalities, the proportions of women fatalities were 134 as compared to 83 men fatalities; and the remaining 39 fatalities were children. This is mainly due to the fact that most affected Kebele (05) is center for small scale business where women are most involved and residing in the area.

Flood in 2006 also severely damaged infrastructure and housing sector. In the housing section, a total of 1628 houses were totally and partially damaged with a total value of 10.23 million USD. The total sum of direct and indirect damages on agriculture and trade and industry sector including cost of demolition and removal of debris was about 2.6 million USD. The overall direct

and indirect disaster impacts occurred in agriculture; trade & industry; and infrastructural sector in the 2006 flooding as per the result of ECLAC calculation was 14.9 million USD. The housing sector is the most severely affected sector in the 2006 flooding in Dire Dawa.

CONCLUSION

- The increasing intensity of rainfall accompanied by forest resource degradation particularly in the upland areas of the catchment has potentially caused floods in the Dire Dawa city.
- The increased extent of the 2006 flood disaster was partly caused by lack of early warning system that could awaken the community to evacuate to safer places before the flood hit the city.
- Ethiopia lacks a comprehensive land-use policy which gave way to increased forestland degradation and this in turn contributed to increased occurrence of flood disaster in downstream areas
- The 2006 flood impact on the socio-economic sector of Dire Dawa was worst that the extent of its impact is incomparable with other flood disasters occurred in the flooding history of Dire Dawa city. Total direct and indirect impacts of flood disaster in all sectors are about 15 million USD.

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