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Flood Risk and Vulnerability of Addis Ababa City Due to Climate Change and Urbanization

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Abstract

Since 1988 Addis Ababa is increasingly affected by flooding. The rapid economic growth of the city increases the urbanization rate significantly, furthermore, an increase in summer season precipitation is expected with a possible risk of flooding. In this research, we analysis the flood risk and vulnerability due to climate change and urbanization using Soil and Water Assessment Tool. The change on peak flow is quantified after careful calibration/validation and uncertainty analysis considering two landsat images and General Circulation Models. The model result indicated that a 10% and 25% increase in peak flow due to climate change and urbanization respectively.

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1. Introduction

For the past 50 years' flood-related disasters in Africa shows an increasing trend [1]and since 1981, floods account about 50 % of the disaster recorded in Sub-Saharan Africa [2]. Addis Ababa (the capital of Ethiopia and Africa) is habitat to one-fourth of the urban population and contributes about half of the national Gross domestic product (GDP) growth of the country [3]. Despite the rapid economic growth and urbanization, flooding is the major development challenge facing the city. Urban flooding is more intensified by dramatic changes in the impervious area, in addition to heavy rainfall and extreme climatic events [4]. According to a remote sensing analysis of the

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study area (Fig.1.), Akaki catchment, the urbanization rate increased by 10% only from 1993 to 2002.

Addis Ababa is vulnerable to riverine as well as flash floods due to extreme climatic events and upper catchment activities and the vulnerability to flooding is more aggravated due to a poor drainage system, rapid housing development along river banks and using inappropriate construction materials [3]. Over one century of rainfall analysis, particularly considering the rainy season (June to September: JJAS) showed an increasing trend of rainfall approximately by 18 mm per decade from 1951 to 2002 [5]. According to the Intergovernmental Panel on Climate Change (IPCC) report, eastern Africa annual rainfall is expected to increase [6]. A recent study by [7] on Ethiopian summer (Kiremt) season using high-resolution models participating in coupled Model Intercomparison Project Phase 5 (CMIP5) under the Representative Concentration Pathway (RCP) 4.5 scenario also shows an increase in precipitation.

Due to rapid urbanization and population increase, low-income communities are forced to settle in flood-prone areas additionally the poor drainage systems of the city also intensify the risk of flooding as well [8]. The reduction of green structures and the increase in the impervious area in urban areas generates more surface runoff even from regular storms [4] and the situations will be more worst when poor people settle in areas which are vulnerable to flooding such as riverine and low-lying floodplains [9]. Considering the flooding risk of Addis Ababa city, in this research we assess the flooding due to climate change and urbanization using Soil and Water Assessment Tool (SWAT) hydrological model. Particularly, the impact of climate change on peak flow (July-August) is quantified using two General Circulation Models (GCMs) participating in the CMIP3 considering SRES A1B emissions scenarios and the urbanization effect is also assessed using remote sensing data of 1993 and 2002 taken from the United States Geological Survey (USGS). Keeping the main objectives of the paper, section 1 presents, a detail background information about the flooding problem in Addis Ababa. Section 2 and 3 describes the study area, the data used and approach followed. Section 4 presents the quantified results of the two scenarios including a discussion about climate and land use change assessment based on the model output. Finally, in section 5 conclusions is drawn by carefully analyzing the quantified results of climate change and urbanization impacts on flooding.

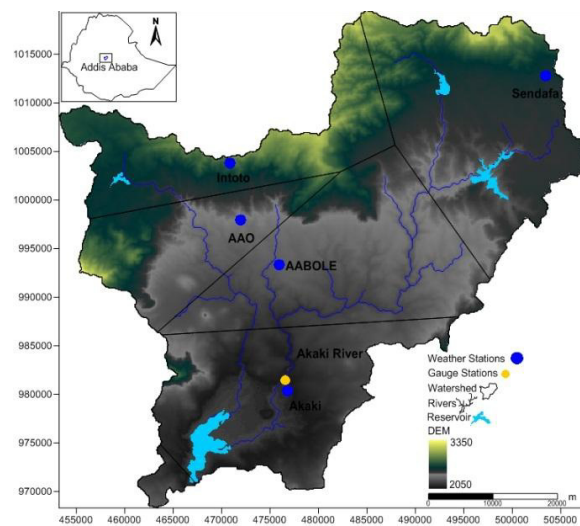


Fig. 1. Study area description

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