Seismicity Study and Hydrological Models Around Bahr Eljabel, South Sudan

Khalda Yassin Ibrahim

Abstract: South Sudan is classified as an area of high seismic activity; Bahr Eljabel is the main stream in this region. The main objective of this research was to generate the hydrological models and to study seismic activity in the area around Bahr Eljabel. The digital elevation data of the study area was mosaicked using Global mapper10 and used as input data to Arc GIS software to delineate the flow direction, flow accumulation, stream link and stream network. The hydrological models show the streams in the study area are consisting of five orders. The depth distribution illustrated that earthquakes are of shallow type and the magnitude interpolation map shows the variation of magnitude from place to another ranges from 3.7 to 6.5. The relation between the earthquakes frequency and months display that the high frequency was observed in May, June and July (the wet season). This paper clearly demonstrates the use of digital elevation model to create hydrological models and revealed the distribution of the seismic activity around bahr Eljabel.

Key words: Bahr el jabel • Seismic activity • Digital elevation model • Flow direction • Stream order

INTRODUCTION

Hydrologic models are simplified, conceptual representations of a part of the hydrologic cycle. The occurrence of water in the subsurface and alteration in the amount of water on the surface or within the subsurface, can influence the presence of earthquakes. The water can influence seismicity the changes in the loading of the surface, the clearest examples follow the impoundment of water by reservoirs ([1], the effective stress is produced by changes in fluid pressure, such as the seismicity induced by changes in pore pressure is caused by fluid injection [2]. Seismic wave speeds in unsaturated rocks will be varying from those in saturated rocks. There are strong relations between seismic, hydrogeologic properties and liquid pressure, spatial movement of reservoir-induced seismicity, seismicity induced by liquid injection ([3]. For many years, changes in fluid pressure in the subsurface and the direction, amount and rate of water flow in streams have been monitored following large earthquakes. Many researchers studied the relation between earthquake and hydrology for example the relation between earthquake and stream flow changes was studied by ([4], the increase in the stream flow at Sespe Creek, California after earthquake was noticed by [5], the relation between the post earthquake ground actions with the pore-pressure transients was studied by [6], the phase shifts in the water-level response to tidal strain after many earthquakes in southern California was documented by [7]. The earthquake hydrology was studied by [8], [9] and [10]. The response of Alum rock springs to the October 30, 2007 earthquake was represented by [11]. A big earthquake struck Juba area in May 1990, the importance of these events lies in the fact that they this earthquake is one of the strongest seismic events that occurred in Africa in the nineteenth of this century, this study aims to study the seismic activity, the hydrological properties of the study area and finding out the relationship between them.

The Study Area: The study area is located between latitudes 4° 50' & 5° 35' N and longitudes 31° 30' & 32° 15' E. The climate ranges from arid in the north to tropical in the far southwest, in the south generally the year is divided into wet and dry season. The wet season lasts from mid-March to mid–October. Generally, the drainage system includes many rivers such as Aswa, Kit and Atebi, all of that are the major tributaries of the Bahr el Jebel which is one of the most important branches of the White Nile.

Corresponding Author: Khalda Yassin Ibrahim, Remote Sensing and Seismology Authority, National Center for Research, Khartoum, Sudan. Mob: +249918312634.
MATERIALS AND METHODS

The current research based on different types of data, such as digital elevation model (90 m grid) obtained from the SRTM (USGS) and the seismicity data obtained from the catalog of the seismicity of Sudan and International Data Center Catalog (ISC), UK. This research was performed basically in the creation of the hydrological models based on remotely sensed data (DEM) and the study of the seismic distribution based on the available historical earthquakes of this part. The digital elevation model was used as input data to the Arc GIS software for automatic generation of the hydrological modelling such as flow direction, flow accumulation and stream order. Seismicity data were used to study the distribution of the earthquake activity in the study area, also kriging method was used to create maps of earthquakes depth and magnitude.

RESULTS

Generally, Baher Eljabel has a watershed extending in the South Sudan and it has many tributaries as mention above. Fig (1) shows the flow direction of the study area where the cells flowing to the north are displayed in dark green color, the cells flowing to the south are displayed in red color, the cells flowing to the east are displayed in violet color, the cells flowing to the west are displayed in yellow color, the cells flowing to the northeast, the northwest, southeast and southwest are displayed in blue, brown, light green and light blue respectively. Figure (2) illustrates the stream order and earthquakes magnitude distribution for the study area where the main stream in the study area is shown in blue (order five), the ordering gradient ranges from five to one, generally the seismic activity is associated with the stream network, the earthquakes activity are concentrated on the eastern part of the study area more than western part. Figure (3) shows the interpolation map of earthquakes magnitude which the dark violet color delineates high magnitude reach to 6.5 mb and the brown color represents low magnitude reach to 3.7 mb and figure (4) illustrates the interpolation map of the earthquakes depth which the dark violet color delineates high earthquakes depth reached to 46.6 Km. Figure (5) represents the histogram of months and magnitude, it was observed that the high magnitude is recorded in the May and July. Figure (6) shows the relation between earthquake frequency and month where the high frequency is observed in May, June and July.
CONCLUSION

The remotely sensed data (digital elevation model) were used in this study to generate the hydrological models. The flow direction, flow accumulation and stream order were obtained. The earthquakes depth and magnitude interpolation maps were created. The earthquake frequency is expected to increase in the wet season (May, June and July) where the soil is saturated. Also, most of the events are associated with the stream network and this may reveal the relation between the hydrological properties and seismic activity in this area.

REFERENCES


