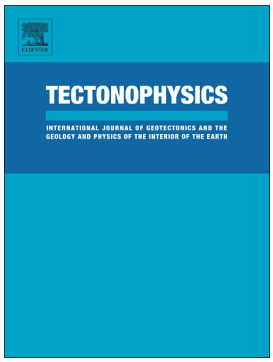

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Recent Ground Deformation around Lake Nasser Using GPS and InSAR, Aswan, Egypt

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Abstract: The rate of seismic activity around lake Nasser rapidly increased after the creation of the High Dam. The largest earthquake recorded in this area was the November 14, 1981, with magnitude M_L 5.6 located 60 km Southwest of Aswan High Dam. We use 16 years of GPS measurements collected around the northern part of lake Nasser, represented by 27 GPS sites, plus eight years of Envisat SAR scenes, 35 descending scenes, to estimate the recent ground movement of this area. GPS and InSAR showed a land subsidence localized around lake Nasser. The subsidence has a magnitude of 1-2 mm/yr. Therefore, we model the Earth's response to water level changes, using full daily water level variations starting from 1982 to 2016. Our loading model captures a similar deformation pattern, like ones estimated from GPS and InSAR, around the lake with comparable amplitudes. With respect to stable Nubia, most of GPS sites around the lake show a negligible North to Northeast motion of less than 1 mm/yr. Along Kalabsha fault, we estimate a strike-slip motion with an extension component of 0.6 mm/yr. GPS sites around Sayal fault do not show any differential motion along the fault in both fault-parallel and fault-normal components. The InSAR result would not be able to capture the deformation at Kalabsha and Sayal region, since the deformation in this area is less than 1 mm/yr.

1. Introduction

Seismicity around lake Nasser has dramatically changed after the full filling of the reservoir behind the High Dam. Many minor scale earthquakes were recorded since 1971. The largest earthquake recorded in this area was the November 14, 1981, Southwest of the Dam with magnitude of 5.6 M_L. Structurally, the area is governed by faulting. There are two main trends of faults, East-West and North-South. The most active faults are the East-West Kalabsha and Sayal faults. Both faults are located West of the lake with no evidence of an extension to the East of the lake. Most of seismic activities are concentrated at the intersection of E-W and N-S faults, as shown in Figure 1. This area is characterized by micro-earthquake activity with magnitude less than 3 M_L. Figure 1 shows the focal mechanism solutions for 37 events, recorded by the Egyptian National Seismic Network (ENSN), with magnitude higher than 2.3 M_L occurred between 1981-2015, in addition to the ISC (International Seismological Center) solution for 1981 earthquake. As shown in the focal mechanism, the strike-slip pattern is dominant with a little extension component (Hussein et al., 2013). Most significant earthquakes are concentrated along the Kalabsha fault, especially when the fault reaches the lake. A statistical analysis for the seismic activity in Aswan region shows two depth classes of seismic events, shallow and deep, with a threshold of 12 km (Telesca et al., 2017). They conclude that the Aswan seismicity is influenced by the water level fluctuations of the lake. This influence is affecting both shallow and deep seismicity, since a noticeable annual periodicity is well correlated with annual loading of the lake.

Due to the great importance of this region, since it includes one of the most strategic constructions in Egypt (High Dam), the crustal movements around the lake have been studied under the umbrella of the National Research Institute of Astronomy and Geophysics (NRIAG). The first attempts to estimate the recent crustal movements around the northern part of lake Nasser were done using the terrestrial techniques (Vyskočil et al., 1991a; Vyskočil et al., 1991b; Mohamed, 1997). In the