

The decline of the Nasca culture (Peru) as the result of an increasing environmental stress: overcoming the paradigm formulated at Cahuachi of catastrophic mega-floods due to El Niño-Southern Oscillation

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Cahuachi, located on the coastal desert of Southern Peru (Nasca Province), represented the main ceremonial site centre of the Nasca culture. An hypothesis of destruction of the site related to catastrophic floods (the youngest around the 10th century AD), due to El Niño-Southern Oscillation (ENSO) was proposed by Grodzicki three decades ago. This paradigm finally led to believe that Cahuachi was covered by huge floods accumulating conglomerates up to the top of the highest buildings. By contrast archaeological evidence in the Nasca Phase IV period emphasizes a high-magnitude earthquake and two moderate-to-major, non-catastrophic floods between 400 and 450 AD, leading to the progressive abandonment of large areas of the ceremonial centre.

To test the above hypothesis, a stratigraphic succession outcropping on the bedrock of the “Pirámide Sur” at Cahuachi was investigated by means of mineralogy, petrography and sedimentology. The succession consists of mudstones, siltstones, sandstones and conglomerates, all sharing similar silty-clayey components. Conglomerates, likely resulting from progradation of alluvial fan systems, have the same lithotypes of pebbles. In addition, the conglomerates occurring at the top of the section unequivocally underlie the ceremonial buildings. It is worth to note, the surveyed stratigraphic section well correlates with the Upper Pliocene-Lower Pleistocene “Changuillo Formation”. This finding is at odd with the late Holocene age proposed by Grodzicki for this succession. However, the hydrogeological hazard assessed at Cahuachi (the occurrence of *huaycos* i.e. debris flows triggered by extreme rain events) and intense periods of earthquake activity are consistent with the progressive influence of destructive natural events on the decline of the Nasca culture. We thus analysed the ENSO cycle in the Peru margin, to check the possible correlation of times of more intense activity with the period of the Cahuachi and Nasca cultures decline.

As the rainfalls in the western Pacific and the eastern and mid Pacific are closely related to the Southern Oscillation Index (SOI) the apparent increase of this latter from 200 to 700 AD, might be closely associated to a strengthen of La Niña events (wet condition), with a period of environmental crisis leading to several moderate-major *huaycos* rather than catastrophic floods. In addition, based on criteria and data available from the National Geophysical Data Center, NOAA, an earthquake of magnitude similar to one of the nine most significant of the area in the last six centuries, hit Cahuachi during Phase IV. We suggest, that, rather than the mere effect of ENSO-related catastrophic floods, the decline of Cahuachi was related to a complex succession of natural disaster events. A progressive weakness of the resiliency of the Cahuachi population, coupled with possible changes in social acceptance of the environmental stress as motivated by the religious hierarchy, will be unraveled.