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Connectivity among sinkholes and complex networks: The case of Ring of Cenotes in northwest Yucatan, Mexico

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A 180-km-diameter semicircular alignment of abundant karst sinkholes (locally known as cenotes) in northwestern Yucatán, México, coincides approximately with a concentric ring of the buried Chicxulub structure, a circular feature manifested in Cretaceous and older rocks, that has been identified as the product of the impact of a meteorite. The secondary permeability generated by the fracturing and faulting of the sedimentary sequence in the Chicxulub impact, has favored the karstification process and hence the development of genuine underground rivers that carry water from the continent to the sea.
The study of the structure and morphology of the crater has allowed researchers to understand the key role of the crater in the Yucatán hydrogeology. It is generally accepted that the Ring of Cenotes, produced by the gravitational deformation of the Tertiary sedimentary sequence within the crater, controls the groundwater in northern Yucatán. However, today there is not solid evidence about the connectivity among cenotes, which is important because if established, public policies could be designed to manage sanitary infrastructure, septic control, regulation of agricultural and industrial activities and the protection of water that has not been compromised by anthropogenic pollution. All these directly affect more than half a million people whose main source of drinking water lies in the aquifer. In this contribution we investigated a set of 16 cenotes located in the vicinity of a gravimetric anomaly of Chicxulub crater ring, using complex networks to model the interconnectivity among them. Data from a geoelectrical tomography survey, collected with SuperSting R1/IP equipment, with multi-electrodes (72 electrodes), in a dipole-dipole configuration was used as input of our model.
Since the total number of cenotes on the ring structure amounts to about 2000, the application of graph theoretic algorithms and Monte Carlo simulation to efficiently investigate network properties is proposed. We created a digital network model representing the observation network topology.