A Spatial-Temporal Representation of Land Subsidence in the Northwest Phoenix Valley, Arizona

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Data Processing:
Each study area received digitized land subsidence polygons, cross-sections and sample location points separated by 1 mile. The temporal durations between InSAR processing ranged between 165 days to over 12,000 days.

Results:
Both study areas had three temporally chaotic subsidence features. Temporally chaotic results were matched across three locations. The results of land subsidence are increased susceptibility to flooding, structural damages, cracks in roads, and water systems. The cross-sections of the study areas were used to extract information from InSAR data processing.

Research Questions:
1. Can the temporal state of land subsidence be derived from InSAR data processing?
2. What are the query limitations of GIS both spatially and temporally for the derived results?
3. Can this information then be effectively represented with GIS to in the hope to simplified subjective analysis to advance our understanding of land subsidence?

Methods:
The land source documents were re-referenced for each study area. An additional requirement was that InSAR was used to compute land subsidence. For consistency, both areas were to be processed the same. A controlled variation was added to each Study Area with an additional data source. Study Area "A" included field survey land subsidence information from 1957-1991. Study Area "B" included the processing of Leveld (raw amplitude and phase) data from TerraSAR-X for the creation of InSAR. At the core, a total of six maps from ADWR showing land subsidence were used as a common source. Primarily secondary observations on land subsidence were used to generate one mile location. This was done to enable a digital profile to be generated. Digitized polygons provided attribution based on their source document. Velocity was calculated in centimeters to maintain conformity with source documents.

Dynamic Phenomena:
There are currently 26 identified active land subsidence features in the state of Arizona covering over 2,000 square miles. By means of spatial query, 15 of the 26 land subsidence features are partially or completely within a few of Arizona’s Urbanized Areas (Avondale, Phoenix - Mesa, and Tucson have known land subsidence features). This is important because the impact from land subsidence has various potential consequences.

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Space and Time GIS:
Space-time GIS is not an easy task as both are continuous and too rich in detail to fully capture without generalizations. Donna Peuquet has offered the “Space-time Triad” as part of a theoretical framework that three spatial GIs should be scalable when dealing with spatio-temporal data in a complex system. The multiple time spans showed how trending in velocity at some locations risk critical infrastructure as the results were temporally chaotic.

InSAR Processing:
The behavior of land subsidence was determined to be spatially chaotic. The multiple time spans showed how trending in velocity at some locations were not consistent for each location. The data processing showed land subsidence velocity, if modeled, could be problematic for all critical infrastructure as the results were temporally chaotic.

GIS Representation:
The representation of land subsidence, although not new to GIS has now been noted in recent research. Interferometric Synthetic Aperture Radar (InSAR) is a method for mapping surface velocity and ground height changes using pairs of synthetic aperture radar images. The technique, or InSAR, is widely used in the field of geophysics to measure ground movements and changes in terrain, such as land subsidence and uplifting. It is also used in environmental monitoring, such as monitoring changes in river flow, sea ice thickness, and volcanic activity. InSAR is a non-intrusive and non-contacting method that can provide high-resolution and high-precision data. The technique is based on the principle of interferometry, which involves measuring the phase shift of a radar signal reflected from a target and a reference point, and then converting the phase difference into a displacement measurement. Compared to traditional surface monitoring methods, such as Global Positioning System (GPS) and LANDSAT imagery, InSAR provides continuous, precise, and real-time data without the need for physical access to the measurement site. The use of InSAR for land subsidence monitoring has several advantages over traditional methods. It is non-intrusive and non-contacting, meaning that it does not require physical access to the measurement site. It is also non-destructive, meaning that it does not alter the target or the environment in any way. InSAR can provide continuous, precise, and real-time data, allowing for the early detection of land subsidence events. It is also cost-effective, as it can be used to monitor large areas with a single instrument. Additionally, InSAR can provide high-resolution data, which can be used to identify small-scale movements and changes in terrain. InSAR has been used in many applications, including monitoring landslides, volcanic activity, and oil and gas field operations. It has also been used to monitor infrastructure, such as bridges and buildings, and to detect changes in the Earth's surface, such assubsidence, uplift, and tectonic movements. InSAR is a powerful tool for monitoring land subsidence and other geophysical phenomena, and it is an important method for ensuring the safety and stability of infrastructure and ecosystems.