Investigation of subsidence of Mahidasht plain of Kermanshah province using radar interferometry method

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Introduction

Landslides are one of the major geological problems around the world that cause compaction of subsurface layers. The cause of this phenomenon can be attributed to human activities such as uncontrolled abstraction of groundwater and natural activities such as earthquakes. Landslides are also one of the main geological hazards in the region, causing serious damage to buildings, roads, infrastructure and bridges. According to the US Geological Survey, subsidence involves the collapse or subsidence of the earth's surface, which can have a small displacement vector. Therefore, identifying and monitoring the subsidence phenomenon is one of the most important and vital issues to maintain stability in the regions. For this purpose, researchers use various methods to study and observe this phenomenon, which are divided into three categories based on the position of the tools used: Subsurface methods, Ground Based methods and Remote Sensing methods. One of the most important of these methods is remote sensing, which collects data from the air or space using satellites, airplanes, or unmanned vehicles and balloons. Radar interference or InSAR, as one of the methods of processing radar images in active remote sensing, is one of the most accurate and economical methods that allows the detection and detection of differences in altitudes created in the shortest time and for large areas.

Data and Method

The study area is located in western Iran and one of the parts of Kermanshah city located in Kermanshah province is located in the area between latitudes 42 degrees and 9 minutes north and longitude 36 degrees and 2 minutes east. Radar interferometry studies in this study were taken by sentinel 1 satellite imagery of the C band. In this study, data from Sentinel 1 satellite in C-band were used. Using image processing with SARSCAPE 5.2 plugin in ENVI 5.3 software platform and using interferometry method, areas exposed to subsidence and the amount of subsidence in each area were determined. In the present study, the relationship between groundwater level drop and subsidence of Mahidasht plain has been investigated. For this purpose, groundwater depth data of 31 piezometer wells in Mahidasht plain were used. In terms of time, considering the accurate and available statistics, the statistics of 1394 and 1398 were cited. The steps of the research were as follows: after preparing the statistics of piezometric wells, the data reconstruction method was used to eliminate the deficiencies in the study data. The reconstruction method used, which was used only to correct the defects in the data, is the interpolation method, which was performed by Neural Power software (based on artificial neural network). To normalize the data, logarithmic transformations were used in SPSS 16 software and GS+ software was used for geostatistical analysis.

Results and Discussion

Examination of subsidence status during the study years shows that from 2015 to 2020, the rate of subsidence has increased. In Figure 1, the areas marked in red have the highest subsidence, the areas marked in green and yellow have the least subsidence, and the areas marked in black have no subsidence. According to the subsidence map of the region, the maximum average subsidence rate in the study area reaches 16 cm. According to the extracted subsidence map of the study area, it is observed that the highest amount of subsidence occurred in the eastern part of Mahidasht plain, which decreased to the west of the plain, so that in the western and south western part of the plain, the lowest Subsidence is observed.

Relationship between groundwater extraction and land subsidence phenomenon Considering that groundwater abstraction is one of the important causes of subsidence in Mahidasht plain, in order to explain the trend of groundwater level changes, the general trend of annual water level of all wells were examined. According to the groundwater level interpolation map, the groundwater depth in Mahidasht plain varies from a maximum of 21.62 meters in 1994 to a maximum of 24.71 meters in 1998.

Conclusion

Land subsidence is a pervasive phenomenon in the world, which has had a significant quantitative and qualitative manifestation in recent decades, mainly due to the improper exploitation of groundwater resources and the intensification of its decline. In the present study, the relationship between groundwater level drop and subsidence of Mahidasht plain has been investigated. Examination of statistics related to the depth of study wells as well as groundwater level zoning maps confirm the decrease of groundwater level. In fact, over-harvesting and lack of balance between feeding the aquifers and draining them has caused the water table in the region to follow a continuous downward trend, with the emptying of water in the cavities of the aquifer and the displacement of water in these cavities with Air reduces the equilibrium pressure between the layers. Due to the disturbance of the balance between the pressure and the weight of the upper layers, due to the force of the weight of the upper layers, the aqueous layers are compressed and the water table decreases and because this decrease has a direct relationship with subsidence. Therefore, in order to deal with this environmental problem, it is recommended to prevent the development of subsidence in the region or to minimize the occurrence of this phenomenon as much as possible by managing land use in the area of subsidence and also adequate supervision over the extraction of underground resources.

Key Words: Groundwater, Radar Interference, Mahidasht Plain Kermanshah, Subsidence

Refrences:

- آروین، عبدالخالق، وهابزاده کبریا، قربان، موسوی، سیدرمضان، بختیارکیا، مسعود (1398) مدل‌سازی مکانی فرونشست زمین در جنوب حوزه آبخیز میناب با استفاده از سنجش از دور و سیستم اطلاعات جغرافیایی، *مجله سنجش از دور و سامانه اطلاعات جغرافیایی در منابع طبیعی*. 10(3)، 19-34.
- احمدی، نعیمه، موسوی، زهرا، معصومی، زهره (1397) مطالعه تکنیک تداخل‌سنجی راداری و بررسی مخاطرات آن، فصلنامه سنجش ازدور و GIS ایران. 10(3)، 33-52.
- امیراحمدی، ابوالقاسم، معالی اهری، نسیم، احمدی، طیبه (1392) تعیین مناطق فرونشست احتمالی دشت اردبیل با استفاده از GIS، *نشریه علمی جغرافیا و برنامه‌ریزی*، 17(46)، 1-23.
- پرهیزکار، سکینه، اژدری، خلیل، کاظمی، غلامعباس، امام قلیزاده، صمد (1394) پیش‌بینی افت سطح آب و ارزیابی فرونشست زمین در آبخوان دامغان با ترکیب مدل‌های جی ام اس و جی ای پی، *مجله علوم دانشگاه تهران*. 5(1)، 80-36.
- حاجب، زهرا، موسوی، زهرا، معصومی، زهره، رضایی، ابوالفضل (1397) بررسی فرونشست دشت قم با استفاده از تداخل‌سنجی راداری، مجموعه مقالات هجدهمین کنفرانس ژئوفیزیک ایران. 18 تا 20 اردیبهشت ماه، انجمن ژئوفیزیک ایران، تهران، 52 -355.

- خورشیددوست، علی محمد، رزمی، رباب، معالی اهری، نسیم، عباس‌زاده، کریم (1396) مطالعه تأثیر نوسانات سطح آب زیرزمینی بر پدیده فرونشست در منطقه قلعه (آذربایجان شرقی، تسوج)، *نشریه علمی جغرافیا و برنامه‌ریزی*. 21(60)، 81-101.
- دهقانی، مریم (1394) ارائه الگوریتمی جدید بر مبنای تکنیک تداخل‌سنجی راداری به منظور پایش فرونشست سطح زمین ناشی از استخراج آب‌های زیرزمینی، *نشریه مهندسی فناوری اطلاعات مکانی*. 2(2)، 73-61.
- شریفی‌کیا، محمد (1390) بررسی پیامد ناشی از پدیده فرونشست در اراضی و دشت‌های مسکون کشور، *مجله علمی و پژوهشی زمین‌شناسی مهندسی*. 3(4 و 5)، 43-85.
- شریفی کیا، محمد (1391) تعیین میزان فرونشست زمین به کمک تداخل‌سنجی راداری در دشت نوق و بهرمان، *مجله آمایش و فضا*. 16(3)، 77-56.
- صفاری، امیر، جعفری، فرهاد، توکل، محمد (1395) پایش و فرونشست زمین و ارتباط آن با آب زیرزمینی مطالعه موردی دشت شهریار و کرج، *پژوهش‌های ژئومورفولوژی کمی*. 5(2)، 93-82.
- صالحی اسفندرانی، رضا، غفوری، محمد، لشکری پور، غلامرضا، دهبان، مریم (1392) بررسی فرونشست دشت مهیار جنوبی با استفاده از روش تداخل‌سنجی راداری، *مهندسی آبیاری و آب ایران*. 3(11)، 57-47.
- علایی طالقانی، محمود. (1384). ژئومورفولوژی ایران. چاپ سوم، انتشارات قومس، تهران.
- محمدی، آرمان. «ارزیابی تراکم مخزن و فرونشست سطح میادین هیدروکربوری با استفاده از روش تداخل‌سنجی رادار و مدلسازی‌های ژئومکانیکی: مطالعه موردی میدان نفتی درود»، پایان‌نامه کارشناسی ارشد، مهندسی معدن، نفت و ژئوفیزیک، 1398، دانشگاه صنعتی شاهرود.
- مرادی مطلق، جعفر. «نقش عوامل طبیعی در اسقرار و توزیع محوطه‌های باستانی دشت ماهیدشت»، پایانه کارشناسی ارشد، 1387، دانشگاه رازی کرمانشاه.
- Aslan, G., Cakı, Z., Ergintav, S., Lasserre, C., Renard, F. (2018), Analysis of secular ground motions in Istanbul from a long-term InSAR time-series (1992–2017), Remote Sensing, 10(3): 408-419.
- Brambati, A., Carbognin, L., Quaia, T., Teatini, P., Tosi, L. (2003), The Lagoon of Venice: geological setting, evolution and land subsidence, Episodes, 26(3): 264-268.
- Chatterjee, R.S., Fruneau, B., Rudant, J.P., Roy, P.S., Frison, P., Lakhera, R.C., Dadlhwal, V.K., Saha, R. (2006), Subsidence of Kolkata (Calcutta) City, India during the 1990 as observed from space by Differential Synthetic Aperture Radar Interferometry (D-InSAR) technique, Remote Sensing of Environment. 102: 176-185.
- Ding, X.L., Liu, Z.W., Li, Z.L., Chen, Y.Q. (2004), Ground subsidence monitoring in Hong Kong with satellite SAR interferometry, Photogrammetric Engineering and Remote Sensing, 70(10): 1151−1156.
- Daniel, R., C. Maisons, C. Carnec, S. Le Mouelic, C. King and S. Hosford.)2003(, Monitoring of slow ground deformation by ERS radar interferometry on the Vauvert salt mine (France) Comparison with ground-based measurement. Remote Sensing of Environment, 88(4): 468-478.
- Guo, J., Zhou, L., Yao, C., Hu, J. (2016), Surface subsidence analysis by multi-temporal InSAR and Grace: A case study in Beijing, Sensors, 16(9): 1495-1503.
- Gutiérrez, F., Benito-Calvo, A., Carbonel, D., Desir, G., Sevil, J., Guerrero, J., Martínez-Fernández, A., Karamplaglidis, T., García-Arnay, Á., Fabregat, (2019), Review on sinkhole monitoring and performance of remediation measures by high precision leveling and terrestrial laser scanner in the salt karst of the Ebro Valley, Spain, Engineering Geology, 248: 283-308.
- Hooper, A.J., (2006), Persistent scatter radar interferometry for crustal deformation studies and modeling of volcanic deformation. Remote Sensing of Environment. 112: 126-145.
- Smith, R.G., Knight, R., Chen, J., Reeves, J.A., Zebker, H.A., Farr, T., Liu, Z. (2017), Estimating the permanent loss of groundwater storage in the southern San Joaquin Valley, California, Water Resources Research journal, 53: 2133-2148.
- Zhu, L., Gong, H., Li, X., Wang, R. (2015), Land subsidence due to groundwater Withdrawal in the northern Beijing plain China, Engineering Geology, 193: 243-255.