United Nations Educational, Scientific and Cultural Organization

Intergovernmental Hydrological Programme

UNESCO Land Subsidence International Initiative

Newsletter of the Unesco Land Subsidence International Initiative

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Conference Papers

Indonesia

The 3rd Southeast Asian Conference on Geophysics 3-5 November 2020, Bandung, Indonesia (Virtual)

Accepted papers received: 28 September 2021

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F M Abdullah et al 2021 IOP Conf. Ser.: Earth Environ. Sci. 873 012034

Results of land subsidence measurement using GPS method in the Jakarta groundwater basin in 2015-2019

https://iopscience.iop.org/article/10.1088/1755-1315/873/1/012034

E J Wahyudi et al 2021 IOP Conf. Ser.: Earth Environ. Sci. 873 012040

Simple design to estimate time-lapse microgravity response due to shallow subsurface density redistribution caused by land subsidence

https://iopscience.iop.org/article/10.1088/1755-1315/873/1/012040

Gumilar et al 2021 IOP Conf. Ser.: Earth Environ. Sci. 873 012044

Extensive Investigation of the Land Subsidence Impressions on Gedebage District, Bandung, Indonesia

https://iopscience.iop.org/article/10.1088/1755-1315/873/1/012044

T P Sidiq et al 2021 IOP Conf. Ser.: Earth Environ. Sci. 873 012078

Land Subsidence of Java North Coast Observed by SAR Interferometry

https://iopscience.iop.org/article/10.1088/1755-1315/873/1/012078

Timothy Antonio et al 2021 IOP Conf. Ser.: Earth Environ. Sci. 873 012081

Integrating Ground Penetrating Radar, Induced Polarization and Aerial Photograph to Analyze Land Subsidence in Borehole Mining Operation Area: A Case Study from South Bangka Island

https://iopscience.iop.org/article/10.1088/1755-1315/873/1/012081

On-Line Course

https://learn.arcgis.com/en/projects/model-how-land-subsidence-affects-flooding/

Model how land subsidence affects flooding

Requirements

ArcGIS Pro (get a free trial)

ArcGIS Spatial Analyst extension

Lesson Plan

Prepare data for analysis

Create the initial elevation datasets that will be used during analysis.

15 minutes

Model land subsidence

Calculate elevation by 2050 due to land subsidence.

10 minutes

Determine damage caused by flooding

Find areas susceptible to flooding and estimate potential damage to buildings.

25 minutes

Compare flooding scenarios

Observe how flooding may change by 2050.

10 minutes

New Literature

Europe

Insana, A. et al., Climate Change Adaptation of Geo-Structures in Europe: Emerging

Issues and Future Steps. Geosciences 2021, 11, 488. https://doi.org/10.3390/geosciences11120488

https://www.mdpi.com/2076-3263/11/12/488/pdf

Great Britain, India

Agarwal, V.; Kumar, A.; Gee, D.; Grebby, S.; Gomes, R.L.; Marsh, S. Comparative Study of Groundwater-Induced Subsidence for London and Delhi Using PSInSAR. Remote Sens. 2021, 13, 4741. https://doi.org/10.3390/rs13234741

https://www.mdpi.com/2072-4292/13/23/4741

Indonesia, peatlands

Deha Agus Umarhadi, Wirastuti Widyatmanti, Pankaj Kumar, Ali P. Yunus, Khaled Mohamed Khedher, Ali Kharrazi, Ram Avtar,

Tropical peat subsidence rates are related to decadal LULC changes: Insights from InSAR analysis,

Science of The Total Environment,2021,151561,ISSN 0048-9697,https://doi.org/10.1016/j.scitotenv.2021.151561.

(https://www.sciencedirect.com/science/article/pii/S0048969721066390)

Abstract: Peatlands in Indonesia are subject to subsidence in recent years, resulting in significant soil organic carbon loss. Their degradation is responsible for several environmental issues; however, understanding the causes of peatland subsidence is of prime concern for implementing mitigation measures. Here, we employed time-series Small BAseline Subset (SBAS) Interferometric Synthetic Aperture Radar (InSAR) using ALOS PALSAR-2 images to assess the relationship between subsidence rates and land use/land cover (LULC) change (including drainage periods) derived from decadal Landsat data (1972–2019). Overall, the study area subsided with a mean rate of −2.646 ± 1.839 cm/year in 2018–2019. The subsidence rates slowed over time, with significant subsidence decreases in peatlands after being drained for 9 years. We found that the long-time persistence of vegetated areas leads to subsidence deceleration. The relatively lower subsidence rates are in areas that changed to rubber/mixed plantations. Further, the potential of subsidence prediction was assessed using Random Forest (RF) regression based on LULC change, distance from peat edge, and elevation. With an R2 of 0.532 (RMSE = 0.594 cm/year), this machine learning method potentially enlarges the spatial coverage of InSAR method for the higher frequency SAR data (such as Sentinel-1) that mainly have limited coverage due to decorrelation in vegetated areas. According to feature importance in the RF model, the contribution of LULC change (including drainage period) to the subsidence model is comparable with distance from peat edge and elevation. Other uncertainties are from unexplained factors related to drainage and peat condition, which need to be accounted for as well. This work shows the significance of decadal LULC change analysis to supplement InSAR measurement in tropical peatland subsidence monitoring programs.

Indonesia, Semarang

B. Syahputra et al., The effect of land subsidence on the selection of raw water sources in hotel and apartment buildings in Semarang city

https://iopscience.iop.org/article/10.1088/1755-1315/896/1/012033

Japan, Central Japan

Shimada S., Aichi M., Harada T., Tokunaga T. (2021) Time Variations of the Vertical Component in Some of Japanese GEONET GNSS Sites. In: . International Association of Geodesy Symposia. Springer, Berlin, Heidelberg. https://doi.org/10.1007/1345_2021_135

https://link.springer.com/chapter/10.1007/1345_2021_135

PR China, Beijing

Sun, H., Zhu, L., Guo, L., et al. : Understanding the different responses from the similarity

between displacement and groundwater level time series in Beijing, China. Natural Hazards (2021)

https://doi.org/10.1007/s11069-021-05041-9

PR China, Ningtiaota Mine

Fu, Y. et al., Ground Fracture Development and Surface Fracture Evolution in N00 Method Shallowly Buried Thick Coal Seam Mining in an Arid Windy and Sandy Area: A Case Study of the Ningtiaota Mine (China). Energies 2021, 14, 7712. https://doi.org/10.3390/en14227712

PR China, Taiyuan Basin

Wei Tang, Xiangjun Zhao, Mahdi Motagh, Gang Bi, Jing Li, Mingjie Chen, Hua Chen, Mingsheng Liao,

Land subsidence and rebound in the Taiyuan basin, northern China, in the context of inter-basin water transfer and groundwater management, Remote Sensing of Environment, 2021, 112792, ISSN 0034-4257, https://doi.org/10.1016/j.rse.2021.112792.

(https://www.sciencedirect.com/science/article/pii/S0034425721005125)

Abstract: The freshwater scarcity and sustainability of overexploited aquifers have been recognized as a big threat to global water security for human development. Consequently, much research has focused in the past on negative consequences of groundwater abstraction, but somewhat less has been documented about the impacts of adequate management practices to address water shortages. Here, using an integrated analysis of InSAR displacement data, groundwater, and geophysical modeling we show how combined management provisions and inter-basin water transfer project has affected the aquifer system in Taiyuan basin in North China. Following groundwater recovery, the alleviation of land subsidence was found with rates being reduced by up to ~70% in the period 2017–2020 with respect to the period 2007–2010. The increase in pore pressure caused by rising groundwater in Taiyuan city, north of the basin, turned four subsidence centers with rates exceeding 110 mm/yr in the 1980 to uplift centers with rates up to +25 mm/yr between 2017 and 2020. A simple linear elastic model for homogenous subsurface properties can explain InSAR-measured surface displacements well. In the central basin, we found a significant seasonal displacement with annual amplitude up to 43 mm (negative peak in autumn and positive peak in spring) related to the groundwater recharge and discharge due to agricultural pumping irrigation. Using cross-wavelet method, we showed a relatively short time lags (less than one month) between surface deformation and water level changes in the central basin, indicating the low-permeability clayey units have a limited influence in delaying the compaction of aquifer system. Quantifying the effects of adequate groundwater management measures and large-scale engineering approaches like inter-basin water transfer to recharge pumped aquifers provide insight for local governments and decision-makers to properly evaluate the impacts of their policy in recovering the sustainability and efficiency of aquifers in water-deficient basins.

PR China, Tibet

With Roberto as one of the co-authors:

Liu Xiaojie et al,

Three-dimensional and long-term landslide displacement estimation by fusing C- and L-band SAR observations: A case study in Gongjue County, Tibet, China

https://www.researchgate.net/publication/355575072_Three-dimensional_and_long-term_landslide_displacement_estimation_by_fusing_C-_and_L-band_SAR_observations_A_case_study_in_Gongjue_County_Tibet_China

PR China, Yellow River Delta

Zhang, Y.; Liu, Y.; Zhang, X.; Huang, H.; Qin, K.; Bai, Z.; Zhou, X. Correlation Analysis between Land-Use/Cover Change and Coastal Subsidence in the Yellow River Delta, China: Reviewing the Past and Prospecting the Future. Remote Sens. 2021, 13, 4563. https://doi.org/10.3390/rs13224563

Taiwan,

Tatas, Hone-Jay Chu, Thomas J. Burbey,

Estimating future (next-month's) spatial groundwater response from current regional pumping and precipitation rates, Journal of Hydrology,2021,127160,ISSN 0022-1694,

https://doi.org/10.1016/j.jhydrol.2021.127160.

Abstract: The equilibrium of natural groundwater systems can be disrupted by excessive withdrawal. Accurate estimation of groundwater levels is needed to assess water-level fluctuations caused by groundwater withdrawal and seasonal distributions of precipitation. This study aims to estimate the next-month's groundwater levels using monthly real-world data that includes rainfall, electricity-estimated pumping volumes, and current groundwater levels invoking time-dependent spatial regression. The new approach involves state-estimation and change-estimation methods, which will be evaluated to determine the optimal model based on its root mean square error values. The response of estimated future (next-month's) groundwater levels within the alluvial fan in Changhua and Yunlin, Taiwan is based on monthly precipitation and pumping. This study yields a data-driven explanation of how water levels temporally and spatially respond to groundwater pumping and rainfall infiltration in different regions within the alluvial fan. Results indicate that the proximal fan yields the smallest response to decreased groundwater levels and subsequent increases in pumping. The effect of reducing groundwater levels is greater in the southern areas of the study site than in the northern areas. Water levels in the mid-fan and distal-fan in the southern area show a greater drawdown due to larger pumping volumes compared to the northern area.

USA, California

Stone, K.M., Gailey, R.M. & Lund, J.R. Economic tradeoff between domestic well impact and reduced agricultural production with groundwater drought management: Tulare County, California (USA), case study. Hydrogeol J (2021). https://doi.org/10.1007/s10040-021-02409-w

USA, North Carolina

Johnston, J., Cassalho, F., Miesse, T. et al. Projecting the effects of land subsidence and sea level rise on storm surge flooding in Coastal North Carolina. Sci Rep 11, 21679 (2021). https://doi.org/10.1038/s41598-021-01096-7

Mining

India, Jharia, Danbad

Kumar, S., Kumar, D., Donta, P.K. et al. Land subsidence prediction using recurrent neural networks. Stoch Environ Res Risk Assess (2021). https://doi.org/10.1007/s00477-021-02138-2

Poland, Wapno

Thi Thu Huong Kim et al.,

Mining-induced Land Subsidence Detected by Sentinel-1 SAR Images: An Example from the Historical Tadeusz Kościuszko Salt Mine at Wapno, Greater Poland Voivodeship, Poland

https://www.researchgate.net/publication/355984968_Mining-induced_Land_Subsidence_Detected_by_Sentinel-1_SAR_Images_An_Example_from_the_Historical_Tadeusz_Kosciuszko_Salt_Mine_at_Wapno_Greater_Poland_Voivodeship_Poland

Poland

Dwornik, M. et al.,Automatic Detection of Subsidence Troughs in SAR Interferograms Using Mathematical Morphology. Energies 2021, 14, 7785.

https://doi.org/10.3390/en14227785

https://www.mdpi.com/1996-1073/14/22/7785/pdf

PR China

Hengfeng Liu, Yanjun Wang, Shun Pang, Xinfu Wang, Jianguo He, Jixiong Zhang, Sebastia Olivella,

Mining footprint of the underground longwall caving extraction method: A case study of a typical industrial coal area in China,

Journal of Hazardous Materials,

2021,

127762,

ISSN 0304-3894,

https://doi.org/10.1016/j.jhazmat.2021.127762.

(https://www.sciencedirect.com/science/article/pii/S030438942102731X)

Abstract: Longwall caving mining (LCM) can lead to many environmental problems that have drawn worldwide attention. A previous survey found that most scholars tend to analyze the two issues separately, that is, coal mining-induced subsidence and heavy metal pollution sources in the soil of the mining regions. Based on field monitoring as well as the collection and analysis of soil samples, a previous study estimated ground settlement and analyzed the surface subsidence law and spatial distribution characteristics of heavy metals in soils. Moreover, a geographic information system was combined with multivariate statistical analysis methods to analyze the heavy metal pollution sources

in soils. At the same time, the mechanism of heavy metal accumulation in the subsidence area was analyzed. The study found that the most active subsidence of settlement was 137.5m behind the workface and moved forward with the workface. LCM has already caused significant disturbance to the soils in the Hengyuan Mine. Moreover, the distribution pattern of eight heavy metals was consistent with the surface subsidence law. The sources of heavy metal pollution in the soils were also identified; namely, coal mining-induced subsidence (64.1%) and mixed transportation and wind-mediated spread (35.9%), offering a reinterpretation of the LCM's footprint.

https://www.sciencedirect.com/science/article/abs/pii/S030438942102731X

PR China, Jining, Shandong

Hongdong Fan, Youfeng Liu, Yaozong Xu & Honglei Yang (2021) Surface subsidence monitoring with an improved distributed scatterer interferometric SAR time series method in a filling mining area, Geocarto International, DOI: 10.1080/10106049.2021.2007300

https://www.tandfonline.com/doi/abs/10.1080/10106049.2021.2007300?journalCode=tgei20

PR China, Ningtiaota Mine

Fu, Y. et al., Ground Fracture Development and Surface Fracture Evolution in N00 Method Shallowly Buried Thick Coal Seam Mining in an Arid Windy and Sandy Area: A Case Study of the Ningtiaota Mine (China). Energies 2021, 14, 7712. https://doi.org/10.3390/en14227712

PR China, Yangquan City

Liu, Z., Mei, G., Sun, Y. et al. Investigating mining-induced surface subsidence and potential damages based on SBAS-InSAR monitoring and GIS techniques: a case study. Environ Earth Sci 80, 817 (2021). https://doi.org/10.1007/s12665-021-09726-z

Monitoring

Insar accuracy

Cigna, F. et al., Accuracy of Sentinel-1 PSI and SBAS InSAR Displacement Velocities against GNSS and Geodetic Leveling Monitoring Data. Remote Sens. 2021,13, 4800.

https://doi.org/10.3390/rs13234800

https://www.mdpi.com/2072-4292/13/23/4800/pdf

Peat

Suria Tarigan et al., Peatlands Are More Beneficial if Conserved and Restored than Drained for Monoculture Crops.

https://www.frontiersin.org/articles/10.3389/fenvs.2021.749279/full

Poland

Oleszczuk, R. et al., Rate of Fen-Peat Soil Subsidence Near Drainage Ditches (Central Poland).

Land 2021, 10, 1287. https://doi.org/10.3390/land10121287

https://www.mdpi.com/2073-445X/10/12/1287/pdf

From the Press

Australia, Queensland

DIGGING FOR AG LAND PLANNING DIRECTION

https://www.qff.org.au/presidents-column/digging-ag-land-planning-direction/

Colombia,Cartagena

Satellite data points to land subsidence in Cartagena

https://news.fiu.edu/2021/satellite-data-points-to-land-subsidence-in-cartagena

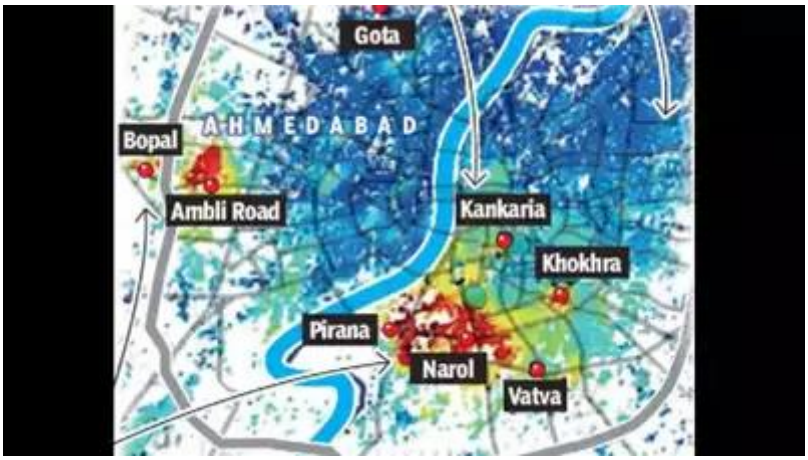
India

India must adapt amid cyclones and subsidence caused by climate change

https://www.pressreader.com/uk/the-scotsman/20211103/281681143102136

India, Ahmedabad

Ahmedabad: 'Walled City least affected by sinking of land'



https://timesofindia.indiatimes.com/city/ahmedabad/walled-city-least-affected-by-sinking-of-land/articleshow/87767081.cms

Indonesia,

A man fishes in water inundating the area around an abandoned building due the rising sea levels and land subsidence in Sidogemah, Central Java, Indonesia, Monday, Nov. 8, 2021. World leaders are gathered in Scotland at a United Nations climate summit, known as COP26, to push nations to ratchet up their efforts to curb climate change. Experts say the amount of energy unleashed by planetary warming would melt much of the planet's ice, raise global sea levels and greatly increase the likelihood and extreme weather events. (AP Photo/Dita Alangkara)

Source: AP

Indonesia, Jakarta

Jakarta to Evaluate Infiltration Well Program

https://en.tempo.co/read/1529380/jakarta-to-evaluate-infiltration-well-program

Iran

Iran's Environmental Catastrophes: Landfall, Subsidence, And Sinkholes – OpEd

https://www.eurasiareview.com/04112021-irans-environmental-catastrophes-landfall-subsidence-and-sinkholes-oped/

Iran, Isfahan

Land Subsidence in Isfahan Reaches Critical Juncture

https://financialtribune.com/articles/energy/111171/land-subsidence-in-isfahan-reaches-critical-juncture

USA, Louisiana

Could Mississippi River diversion overcome sinking land? Two new studies say yes

https://www.nola.com/news/environment/article_e75fba3e-4bd6-11ec-8943-2bfd97a6739d.html

Vietnam, Mekong Delta

Vietnam: Low-lying Mekong Delta deals with worsening land subsidence

https://www.thestar.com.my/aseanplus/aseanplus-news/2021/11/28/vietnam-low-lying-mekong-delta-deals-with-worsening-land-subsidence

Special Issue

Frontiersin

Correlating Subsidence Pattern and Land Use Type

Land subsidence is an environmental, geological phenomenon that often refers to gradual settling or rapid sinking of the ground surface as a result of subsurface movement of earth materials. It is considered to be a global issue, and many cities around the world have been reported suffering from land subsidence at the rate of tens of centimeters per year. The impacts of the subsidence could lead to serious issues, for example, damage to infrastructure, affect the serviceability of roads and railways, and increase exposure to flooding.

Radar interferometry, Global Navigation Satellite System (GNSS), close-range photogrammetry (CRP), Robotic Total Stations (RTS), digital levelling, and other modern geodetic measurement techniques have all played an important role in measuring land deformation data. Land deformation data obtained using these techniques has found widespread application in the spatiotemporal analysis of deformation-prone areas. One of the very interesting topics to study is the relationship between land usage type and land subsidence so that land surface change and/or movement can be better understood and managed to ensure people's safety.

We welcome you to participate in this Research Topic, which will focus on examining the relationship between land usage type and the magnitude of land subsidence. All types of original research contributions will be considered. These include but are not limited to new algorithms, methodologies, and results. Moreover, application papers, including case studies and field measurements, and technical reviews are also welcome.

https://www.frontiersin.org/research-topics/29781/correlating-subsidence-pattern-and-land-use-type