United Nations Educational, Scientific and Cultural Organization

Intergovernmental Hydrological Programme

UNESCO Land Subsidence International Initiative

Newsletter of the Unesco Land Subsidence International Initiative

Vol. 13 April 2021

New Literature

General

Variation in the rate of land subsidence induced by groundwater extraction and its effect on the response pattern of soil microbial communities

Earth Surface Processes and Landforms (IF 3.694) Pub Date : 2021-04-14 , DOI: 10.1002/esp.5133

Neda Mohseni, Roland Bol

Excessive extraction of groundwater leads to (irreversible) changes in the physical soil properties, causing land subsidence associated with soil compaction to occur. Using a combined image processing and field approach, we examined: (1) how variation in the land subsidence rate induces different soil compaction degrees, and (2) the response patterns of microbial communities to such variations. By using Sentinel Synthetic Aperture Radar image processing, we selected three locations that exhibited different land subsidence rates, including high (HSR), moderate (MSR), and low (LSR). Then, soil sampling was undertaken within these representative locations. Indicators of soil compaction, including total porosity, air-filled porosity, water-filled porosity, and bulk density were measured. The soil microbial community was determined using qPCR and sequencing. The highest and lowest values for bulk density were observed in the HSR-MSR and LSR zones, respectively. The greatest values of total porosity and macropore volume were displayed in the LSR zone compared with other zones. Bacterial abundance in the LSR zone was significantly greater than that in the HSR and MSR zones. The relative abundances of bacterial taxa indirectly demonstrated that the anaerobic phyla were significantly increased (by 10 % to 13 %) and aerobic phyla decreased (by 30 % to 40 %) in the HSR zone compared to the LSR zone. This result demonstrates that the aerobes declined as larger volumes of the soil became more anaerobic. Indeed, the increased abundance of anaerobes was not able to compensate for the larger decrease in the abundance of aerobes. Our work showed that at the increased rates of land subsidence, the abundance distribution of microbial community critically declined. These findings highlight the critical impacts of increasing the land subsidence rate on the emergence of high soil compaction degrees, which can significantly affect the resilience thresholds of the microbial communities in dryland soils.

General, Europe

Matteo Del Soldato et al.,

Review of Works Combining GNSS and InSAR in Europe

https://www.mdpi.com/2072-4292/13/9/1684/pdf

Great Britain, peat oxidation

With a reference to *Nature:*

Improved management of farmed peatlands could cut 500 million tons CO2

Reduced emissions from halving drainage depths would be equivalent to 1% of all anthropogenic greenhouse gases

UK CENTRE FOR ECOLOGY & HYDROLOGY

https://www.eurekalert.org/pub_releases/2021-04/ucfe-imo042121.php

Great Britain, London

Case Study:

Urban Monitoring, London

https://communityimpact.com/houston/the-woodlands/2021/04/29/annual-subsidence-report-shows-katy-jersey-village-with-highest-rate-of-ground-sinking-over-time/

Greece, Boeotia county

Detection of land subsidence phenomena in Kopais plain, Boeotia county, central Greece. Preliminary results

DOI: 10.5194/egusphere-egu21-12746 2021 ▫

Authors: Elissavet Chatzicharalampous et al.,

Deposition of organic soils takes place in fresh water and coastal swamps. Due to water presence no oxidation procedure takes place and therefore organic material decomposes slightly. Balance is maintained because accumulation rate is higher than decomposition-oxidation rate. However, drainage of these areas disturbs this balance and creates the appropriate aerobic conditions under which organic matter oxidizes, usually with slow and steady rate. Oxidation is “accompanied” by land subsidence, the rate of which depends on the type of organic matter, depth of the aquifer and temperature.

Kopais plain has general W-E direction, is located in Boeotia county about 100km NW of Athens. It extends in an area of about 250,000 acres and came from the drainage of the homonymous lake, which was extending at the Eastern part of the basin with length of 23km, width 13km and maximum depth 4m. The bottom of the lake consists of a solid layer of clay up to 4 meters thick, rich in organic matter from the decay of plant debris. The lake sides were swamps covered with reeds, shrubs and flowering plants.

Mycenaeans who lived in Orchomenos town were the first to successfully drain the lake in 16th century BC carrying out important and impressive works. After the decline of Mycenaeans the

drainage works were abandoned, destroyed and gradually, in the 13th BC century, the area flooded again and the lake was re-formed.

New drainage works were carried out in period 1882-1886 by "French Kopaida Company". On 1886 discharge of the lake took place and Kopais was drained again.

However, the organic matter located at the bottom of the lake (peat), immediately after drying, self-ignited. The fire spread throughout the whole area of drained Kopais and burned all the peat located close to the surface, resulting to the subsidence of the ground surface by 4m. Consequently, drainage works appeared to be suspended above the ground and unable to drain the water. In 1887 Kopais became a lake again.

In 1895 the English company "Lake Copais Co. Ltd" undertook the continuation of the draining project which was completed in 1931, with the drainage of 241,000 acres of arable land.

In the recent years due to climate change and occurrence of heavy rainfall, the plain floods and parts of it are temporarily turned back into a lake.

After drainage of the lake, the plain has been cultivated intensively. Also, stockraising activity and industry were further developed. Economic development brought the expansion of existing settlements and the creation of new ones mainly in the western area of the dried lake.

The current research presents the results of an ongoing investigation revealing extencive deformations causing damages to buildings and infrastructure at the town of Aliartos and at the villages of Alalkmones, Agios Athanasios, Mavrogia, Agios Dimitrios, Karya and Agios Spyridonas. It is considered that these damages are resulted by land subsidence, mainly induced by the oxidation of the remaining organic material but also amplified by water pumping for watering, industrial and livestocking purposes or even more from the natural compaction of the upper strata.

Indonesia, Pekalongan

Wahyu Luqmanul Hakim et al.,

Mapping Land Subsidence in Pekalongan, Indonesia using Time Series Interferometry and Optimized Hot Spot Analysis with Sentinel-1 SAR Data DOI: 10.5194/egusphere-egu21-3734

https://www.sciencegate.app/document/10.5194/egusphere-egu21-3734

Indonesia, Semarang

Amin, C.; Sukamdi, S.; Rijanta, R.

Exploring Migration Hold Factors in Climate Change Hazard-Prone Area Using Grounded

Theory Study: Evidence from Coastal Semarang, Indonesia. Sustainability 2021, 13, 4335. https://doi.org/10.3390/su13084335

Indonesia, Semarang, Flood Risk

A flood risk map is available (Winrar software required)

https://datacatalog.worldbank.org/dataset/semarang-indonesia-flood-risk-map-esa-eo4sd-urban

Infrastructure

Application of GIS/Geomatics to Areas affected by Subsiding Land and Rising Sea: Simulation of Risks and Identification of At-Risk Infrastructure

By Sanjay Tewari, Francis Manning and Wesley Palmer

https://core.ac.uk/display/229313778

Iran

Alireza Arabameri1 et al.,

Performance Evaluation of GIS-Based Novel Ensemble Approaches for Land Subsidence Susceptibility Mapping

https://www.frontiersin.org/articles/10.3389/feart.2021.663678/abstract

Iran, Shahryar County

Land subsidence susceptibility mapping using persistent scatterer SAR interferometry technique and optimized hybrid machine learning algorithms

Authors:

Ranjgar, Babak et al.,

https://repository.tudelft.nl/islandora/object/uuid%3A8502cc92-4bc3-45ba-ae50-bb23662e92c9

Iran, Tehran

Master Thesis TU Delft, the Netherlands:

Monitoring of power towers' movement using persistent scatterer SAR interferometry in south west of Tehran

Authors:

Tarighat, Fereshteh et al.,

https://repository.tudelft.nl/islandora/object/uuid:e59fb456-b92e-43a6-87d7-61b5b38bc3af?collection=research

Iran

Ashraf, S. et al., Anthropogenic drought dominates groundwater depletion in Iran. Sci Rep 11, 9135 (2021). https://doi.org/10.1038/s41598-021-88522-y

Italy, Po River Delta

Cenni, N.; Fiaschi, S.; Fabris, M. Monitoring of Land Subsidence in the Po River Delta

(Northern Italy) Using Geodetic Networks. Remote Sens. 2021, 13, 1488.

https://doi.org/10.3390/rs13081488

Italy, Sicily

Anzidei, M.; Scicchitano, G.; Scardino, G.; Bignami, C.; Tolomei, C.; Vecchio, A.; Serpelloni, E.; De Santis, V.; Monaco, C.; Milella, M.; Piscitelli, A.; Mastronuzzi, G. Relative Sea-Level Rise Scenario for 2100 along the Coast of South Eastern Sicily (Italy) by InSAR Data, Satellite Images and High-Resolution Topography. Remote Sens. 2021, 13, 1108. https://doi.org/10.3390/rs13061108

Japan, Chiba Prefecture

Muramoto, Yoshiyuki et al., PDCA method for management of land subsidence

Proceedings of the International Association of Hydrological Sciences; Gottingen Vol. 382, : 143-147. Gottingen: Copernicus GmbH. (2020) DOI:10.5194/piahs-382-143-2020

https://search.proquest.com/openview/9c1d0cef5d4fac4850916977f3e7f0ba/1?pq-origsite=gscholar&cbl=2037677

Japan, Kyushu

Don, Nguyen Cao et al., Simulation of groundwater flow and environmental effects resulting from pumping

Environmental Geology; Berlin Vol. 47, Iss. 3, (Feb 2005): 361-374. DOI:10.1007/s00254-004-1158-1

https://search.proquest.com/openview/8437dea45173642d1db8e7e0ae2539a4/1?pq-origsite=gscholar&cbl=54063

Mexico, Mexico City

Enrique collaborated in: E. Chaussard et al.,

Over a Century of Sinking in Mexico City: No Hope for Significant Elevation and Storage Capacity Recovery

https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2020JB020648

Pakistan, Abbottabad

Khan, R.; Li, H.; Afzal, Z.; Basir, M.; Arif, M.; Hassan, W. Monitoring Subsidence in Urban Area by PSInSAR: A Case Study of Abbottabad City, Northern Pakistan. Remote Sens. 2021, 13, 1651. https://doi.org/10.3390/rs13091651

https://www.mdpi.com/2072-4292/13/9/1651

PR China, Tongren County

Jiawen Bao et al.,

An improved distributed scatterers extraction algorithm for monitoring tattered ground surface subsidence with DSInSAR: A case study of loess landform in Tongren county,

International Journal of Applied Earth Observation and Geoinformation, Volume 99, 2021,

102322, ISSN 0303-2434, https://doi.org/10.1016/j.jag.2021.102322.

(https://www.sciencedirect.com/science/article/pii/S0303243421000295)

Abstract: In order to effectively detect the detailed subsidence of tattered ground surface composed of many small fragments with the distributed scatterer interferometric synthetic aperture radar (DSInSAR) technique, a fast and accurate distributed scatterer extraction (FADSE), as an improved distributed scatterers extraction algorithm, is proposed and demonstrated in this paper. The emphasis of FADSE is on the improvement of accuracy of extracted DSs and detection efficiency as well. For the purpose, nonparametric estimation and parametric estimation methods are combined into FADSE to fast identify as many accurate statistically homogeneous pixels (SHP) as possible. Then the thresholds of homogeneous pixel number and coherence coefficient are adjusted to select DSs from SHPs. The validation of FADSE was performed in the case of loess subsidence detection in Tongren county, Qinghai Province of China, using 20 Sentinel-1A SAR images acquired between February 2016 and June 2017. Moreover, FADSE was compared with the Kolmogorov-Smirnov algorithm and Fast Statistically Homogeneous Pixel Selection method. Results show that FADSE is capable of efficiently extracting more DSs that are accurate and the detailed subsidence of tattered ground surface can be accurately detected.

PR China, Xian

Kun Yu, Luchen Wang et al.,

Soil pore characteristics, morphology, and soil hydraulic conductivity following land subsidence caused by extraction of deep confined groundwater in Xi'an, China: Quantitative analysis based on X-ray micro-computed tomography,

Soil and Tillage Research, Volume 211, 2021, 105018, ISSN 0167-1987,

https://doi.org/10.1016/j.still.2021.105018.

(https://www.sciencedirect.com/science/article/pii/S016719872100088X)

Abstract: The extraction of deep confined groundwater has been widely identified as the main factor leading to land subsidence. However, how soil pore characteristics and morphology may change as a result of land subsidence remains unclear. The objective of this study was to (1) quantify and compare the effects of soil compression due to deep confined aquifer exploitation on soil pore characteristics and morphology and (2) assess the relationships between pore parameters and saturated hydraulic conductivity (Ksat). Three kinds of lithology (clay, silt, and silty clay soils) from two 300-m engineering geological boreholes were investigated at natural saturated state (NSS) and complete drainage state (CDS). Seventeen undisturbed soil samples, 70 and 50-mm in diameter and height, respectively, were collected and subjected to steps of uniformly increasing loads in uniaxial confined compression tests to analyze pore characteristics, morphology, and Ksat. Keeping the samples in a strain-locked state, pore parameters were assessed after each loading step by using X-ray micro-computed tomography (CT; voxel resolution: 3-μm) images. A hundred CT images were acquired and quantified for each treatment in each soil sample. Soil pore characteristics and morphological parameters including number of pores, number of macropores (diameter (Ø) > 1000-μm), number of coarse mesopores (Ø 200–1000-μm), number of fine mesopores (Ø < 200-μm), porosity, macroporosity, coarse mesoporosity, fine mesoporosity, largest pore area, average pore diameter, shape factor, structure model index, degree of anisotropy, and the Euler number were analyzed using ImageJ software. All parameters differed between NSS and CDS treatments, especially in silt and silty clay soils below 100-m depth, and the differences seemed to increase with increasing depth. However, parameter variations were not obvious for clay soil. Furthermore, Ksat differed significantly between treatments. The largest pore area, average pore diameter, and regular porosity accounted for 78.2 % of the change in Ksat. Thus, the decrease in proportion of elongated

macropores favors land subsidence, particularly in silt and silty clay soils below 100-m depth. Efforts such as optimization of groundwater exploitation depth should be made to alleviate and control land subsidence.

Keywords: Uniaxial confined compression test; CT image analysis; Pore parameters; Hydraulic conductivity

Spain, Madrid aquifer

Tomás, Roberto; Pastor, José Luis; Béjar-Pizarro, Marta; Bonì, Roberta; Ezquerro, Pablo; et al.

Wavelet analysis of land subsidence time-series: Madrid Tertiary aquifer case study

Proceedings of the International Association of Hydrological Sciences; Gottingen Vol. 382, : 353-359. Gottingen: Copernicus GmbH. (2020) DOI:10.5194/piahs-382-353-2020

USA, Louisiana

Document: Environmental Threats To Louisianas Future Climate Change

https://www.scribd.com/document/259697520/Environmental-Threats-to-Louisianas-Future-Climate-Change

USA, Texas

Michelle attended us following:

Annual subsidence report shows Katy, Jersey Village with highest rate of ground sinking over time

https://communityimpact.com/houston/the-woodlands/2021/04/29/annual-subsidence-report-shows-katy-jersey-village-with-highest-rate-of-ground-sinking-over-time/

From the Press

Bangladesh

Subsidence In The Bangladesh Basin

https://notalotofpeopleknowthat.wordpress.com/2021/04/07/subsidence-in-the-bangladesh-basin/

Colombia, Bolivar

Colombia – Thousands Hit by Flash Floods in Bolivar

In 2019 disaster authorities warned of increased flood risk in many El Carmen de Bolivar neighbourhoods due to severe land subsidence.

http://floodlist.com/america/floods-bolivar-colombia-april-2021

Great Britain, Cheshire

A publication in Nature, 1881

Subsidence of Land caused by Natural Brine-Springs A THEORY has been put forward to account for the subsidence of land in the salt districts of Cheshire. It is said that, supposing the manufacturers of salt ceased to pump up the brine, it would run away to the sea, and sub;idence would go on at as rapid a rate as now. Can any of the readers of NATURE tell me of any facts to substantiate such a theory, or refer me to any district where such rapid subsidence is going on, owing to the escape of natural brine-springs to the sea? Any reference to works giving information on this point will be thankfully received.

Northwich, February 15, 1881

Great Britain, Manchester

About: damage to houses as a result of shrinking clay, due to groundwater extraction by trees.

https://democracy.manchester.gov.uk/documents/s23951/109%20Parsonage%20Road.pdf

Indonesia

An overview of information about Land Subsidence in Indonesia is given in:

https://line.17qq.com/articles/tttcwerhx.html

Indonesia,

From the blog of the Worldbank:

JUN ERIK RENTSCHLERCHRISTOPH KLAIBERJIAN VUN|APRIL 14, 2021

Floods in the neighborhood: Mapping poverty and flood risk in Indonesian cities

https://blogs.worldbank.org/eastasiapacific/floods-neighborhood-mapping-poverty-and-flood-risk-indonesian-cities

Sri Lanka, Monaragala

Our aim is to conserve and sustainably utilize water resources of the country by using new technologies and management tools. Hence, the services of the WRB extends to develop the water resources to meet the growing demands of the country in domestic, industrial and agricultural sectors.

Although, Sri Lanka is not considered as a water scarce country, in particular to groundwater, quantity, quality and availability of groundwater has started to deteriorate due to increasing human activities. This undesirable groundwater deterioration relates to land subsidence and seawater intrusion; coincides with urban development and excessive groundwater extraction. WRB is dedicated to research and training people to address these groundwater issues in the country.

http://wrb.gov.lk/monaragala-provincial-office/

Taiwan,

New wells pose no bullet train safety threats: Water agency

https://focustaiwan.tw/society/202104110010

United States, Arizona, Willcox

GROUNDWATER DEPLETION IN WILLCOX, ARIZONA

Diana Hsieh

Department of Hydrology and Atmospheric Sciences, University of Arizona

Willcox is a small town located in southeastern Arizona that sources all their water from the Willcox groundwater basin, which is a closed system. Because Willcox is not an Active Management Area, there is no regulation on its groundwater usage. This has made it extremely attractive for large agricultural farming operations to move into Willcox increasing drawdown rates. Willcox has experienced the largest land subsidence rate in Arizona caused by overdraft of their groundwater. A thorough search of literature revealed that the rate at which groundwater is being used is unsustainable. With a deficit of water recharging their water basin, the residents of Willcox have experienced their wells drying. Without additional conservation and regulation, the Willcox Groundwater Basin will continue to run at a deficit with their water usage. The USGS is currently conducting research on the effects of rock detention structures and their effects on recharge rate in Willcox. This research provides residents with a possible way to capture, conserve, and increase their water availability.

https://has.arizona.edu/groundwater-depletion-willcox-arizona

United States, Montgomery County

New goals would allow for ground to sink in The Woodlands, more water pumped from Montgomery County

https://www.houstonchronicle.com/news/houston-texas/houston/amp/New-goals-would-allow-for-ground-to-sink-in-The-16109699.php

United States, San Joaquin Valley

Feinstein, Costa Introduce Bill to Restore San Joaquin Valley Canals

https://www.feinstein.senate.gov/public/index.cfm/press-releases?id=AF7E5FD2-AD59-451C-8C84-F5162596DCF7

United States, Texas

Flooding in Texas will be intensified by sinking land

By Kate Baggaley

https://academictimes.com/flooding-in-texas-will-be-intensified-by-sinking-land/

Yemen

Report: Groundwater depletion clouds Yemen's solar energy revolution

https://ceobs.org/groundwater-depletion-clouds-yemens-solar-energy-revolution/?utm_source=rss&utm_medium=rss&utm_campaign=groundwater-depletion-clouds-yemens-solar-energy-revolution

Projects

Indonesia

Project: Strategies for subsiding Jakarta

University of Utrecht, the Netherlands

Northern Jakarta is subsiding. In a few decades from now, it may have fallen an additional 3-5 metres below mean sea level. Unless action is taken, there will be more frequent and prolonged flooding. Until now, little has been achieved in terms of slowing subsidence in North Jakarta. This project aims at helping Jakarta by: (1) Inviting international researchers to discuss the exact causes of subsidence, (2) Setting-up a database with subsurface and geotechnical information, (3) Making improved subsidence predictions in different development scenarios and (4) Coming with a concrete strategy to curtail or even stop subsidence.

Funding: Netherlands Embassy in Jakarta

https://www.uu.nl/en/futuredeltas/project-strategies-for-subsiding-jakarta-0

the Netherlands, development of a new peat-sampler

To improve undisturbed sampling of peat-soils, a new sampling device was developed. Dennis Peters, Deltares, sent me some nice pictures:

Sampling in the field

The sample is taken

Example of a sample

The sample in the sample device

Coastal Change

Following UNESCO proposal was funded:

IGCP 725 Forecasting coastal change: Coastal communities are prone to a range of geohazards, including sea-level rise, storms, subsidence, earthquakes and tsunamis. They can result in major changes to our coastlines, causing loss of life, damage to infrastructure, economic hardship, and degradation of coastal ecosystems. A key scientific goal is the ability to forecast coastal response to driving mechanisms, enabling effective decision-making about how best to manage the coastal zone and reduce risk.

Accurate forecasts of coastal change are best achieved by combining geological field and laboratory data with predictive numerical models. However, coastal geologists and numerical modellers often

approach the issue in different and not always complementary ways. To overcome this key issue, the project will bring together scientists from coastal geology and numerical modelling to improve the predictive capacity of numerical models to fore- and hind-cast coastal change. The project will produce a 'best practice' guide for how geoscientists can effectively use and integrate models into their investigations in a range of coastal settings, with a view towards directly informing management of the coastal zone. To this end, the project will also engage with stakeholders to develop guidelines for effective communication of evidence and science-based coastal policy.
Duration: 2021 - 2026

Geohazards theme

Contact: Jessica Pilarczyk (Canada) email: jessica_pilarczyk@sfu.ca

https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fen.unesco.org%2Figcp%2Fprojects%2F725&data=04%7C01%7C%7C574f708728ec4f3228d608d8fa6b6f53%7C15f3fe0ed7124981bc7cfe949af215bb%7C0%7C0%7C637534686627655184%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C1000&sdata=wbfm5TQGv9KSpftoCT2RZ%2FhhaaboYtz0Lp4lzh11ePA%3D&reserved=0