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Editorial Team: Shankar Bhattarai and Soniya Maharjan

For the 623rd - 624th issues of Headlines Himalaya, we reviewed research articles from four sources and selected thirteen researches from four countries. We selected four researches from Nepal and nine researches from other Himalayan countries (India, China and Bhutan).

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MULTIPLE FACTORS INFLUENCE LOCAL PERCEPTIONS OF SNOW LEOPARDS AND HIMALAYAN WOLVES IN THE CENTRAL HIMALAYAS, NEPAL

Madhu Chetri, Morten Odden, Olivier Devineau, Thomas McCarthy, and Per Wegge

PeerJ 8: e10108

An understanding of local perceptions of carnivores is important for conservation and management planning. In the central Himalayas, Nepal, we interviewed 428 individuals from 85 settlements using a semi-structured questionnaire to quantitatively assess local perceptions and tolerance of snow leopards and wolves. We used generalized linear mixed effect models to assess influential factors, and found that tolerance of snow leopards was much higher than of wolves. Interestingly, having experienced livestock losses had a minor impact on perceptions of the carnivores. Occupation of the respondents had a strong effect on perceptions of snow leopards but not of wolves. Literacy and age had weak impacts on snow leopard perceptions, but the interaction among these terms showed a marked effect, that is, being illiterate had a more marked negative impact among older respondents. Among the various factors affecting perceptions of wolves, numbers of livestock owned and gender were the most important predictors. People with larger livestock herds were more negative towards wolves. In terms of gender, males were more positive to wolves than females, but no such pattern was observed for snow leopards. People's negative perceptions towards wolves were also related to the remoteness of the villages. Factors affecting people's perceptions could not be generalized for the two species, and thus need to be addressed separately. We suggest future conservation projects and programs should prioritize remote settlements.

For further readings: <https://doi.org/10.7717/peerj.10108>

MERCURY VARIATION AND EXPORT IN TRANS-HIMALAYAN RIVERS: INSIGHTS FROM FIELD OBSERVATIONS IN THE KOSHI RIVER

Xuejun Sun, Qiangong Zhang, Mingyue Li, Kshitiz Kandel, Bakhat Rawat, Aastha Pandey, Junming Guo, Shichang Kang, Ramesh Raj Pant, Zhiyuan Cong, and Fan Zhang

Science of The Total Environment 738: 139836

Strengthening the research of riverine mercury (Hg) export is of great significance for understanding the regional and global Hg cycle, especially for the data lacking trans-Himalayan rivers. In this study, three systematic sampling campaigns were conducted in the Koshi River Basin (KRB) during the post-monsoon, pre-monsoon and monsoon seasons. Hg speciation and distribution of river water were analyzed among the different seasons for a total of 88 water samples. The total Hg (THg) concentration of surface water in the KRB ranged from 0.64 to 32.96 ng·L⁻¹ with an average of 5.83 ± 6.19 ng·L⁻¹ and decreased in the order of post-monsoon (8.79 ± 7.32 ng·L⁻¹) > monsoon (6.68 ± 6.12 ng·L⁻¹) > pre-monsoon (2.18 ± 1.29 ng·L⁻¹). Particulate Hg (PHg) accounted for 63% of THg on average and had a positive correlation with THg among all the three sampling seasons, indicating that the differences in PHg concentration were likely one of the main factors leading to the seasonal and spatial variations in THg in the KRB surface water. The annual Hg exports and fluxes were estimated to be 339.04 kg and 3.88 μg·m⁻²·yr⁻¹, respectively. Furthermore, Hg export from the KRB had significant seasonal variation and decreased in the order of monsoon (259.47 kg) > post-monsoon (61.18 kg) > winter (9.31 kg) > pre-monsoon (9.08 kg), and this pattern was mainly related to seasonal changes in river runoff. The annual Hg export is projected to increase in the future, especially in the post-monsoon season. Therefore, more attention should be paid to river runoff observations and riverine Hg research for water resources management in the Himalaya.

For further readings: <https://doi.org/10.1016/j.scitotenv.2020.139836>

WHY IS THE PRIVATE FOREST PROGRAM STUNTED IN NEPAL?

Kishor Aryal, Arjun Rijal, Tek Maraseni, and Manisha Parajuli

Environmental Management 66: 535–548

Private forest (PF) program has the potential to be one of the most efficient forest management programs in Nepal but it has not gained the momentum compared to the other forest management regimes. Considering this, this paper aims to portray policy provisions, existing institutional arrangements as well as landholder experiences and perceptions over the existing mechanisms of PF registration, management, and forest product harvesting. Using the Sudoorpashchim province of Nepal as a case study, we conducted policy and literature reviews, key informant interviews, household surveys, and field observations. We found only 300 PFs registered in the Sudoorpashchim province, with lowland districts having the highest proportion (87%). Institutional arrangements and procedures for timber harvesting and selling were found to be lengthy and complex, with this being a major issue for PF owners with small forest areas. Government initiatives are inadequate to facilitate PF development due to poor implementation of policy provisions, as well as the lack of appropriate incentives and program packages. Despite a very small government investment in PF development, we found the return from PFs in terms of timber supply to be substantially higher than other forest management regimes. Among others, PF owners perceive the cumbersome regulatory procedures and lack of technical support to be the most pertinent factors responsible for the limited growth of PFs. Based on our results, we have discussed and recommended a number of policy and institutional measures to mainstream PF development programs, in order to support economic prosperity of the nation

For further readings: <https://doi.org/10.1007/s00267-020-01343-z>

DATASET OF NON-TIMBER FOREST PRODUCTS USE AND IMPACTS OF RECENT CLIMATE CHANGE IN THE UPPER MADI WATERSHED, NEPAL

Lila Jung Gurung, Kelly K. Miller, Susanna Venn, and Brett A. Bryan

Data in Brief 33: 106404

This dataset presents data collected from household surveys from Upper Madi Watershed of Nepal describing the benefits of non-timber forest products (NTFPs) to people of mountain ecosystems, their perceptions of climate change, and perceived impacts of climate change on NTFPs ecosystem services. The data were collected from 278 households that were randomly selected from the four villages in the watershed during the period September to December 2019. The survey assessed socio-demographic information; collected and utilized NTFPs; perceptions of climate change, and; perceived impacts of climate change on NTFPs ecosystem services. These data are important in understanding the benefits of non-timber forest products in mountain ecosystems and the impacts of climate change as the benefits and impacts are currently not well understood. The data will be helpful in formulation and implementation of adaptation strategies to sustain the supply, protection, and management of NTFPs in mountain ecosystems.

For further readings: <https://doi.org/10.1016/j.dib.2020.106404>

India-Himalaya

EL NINO SOUTHERN OSCILLATION AS AN EARLY WARNING TOOL FOR DENGUE OUTBREAK IN INDIA

Malay Pramanik, Poonam Singh, Gaurav Kumar, V. P. Ojha, and Ramesh C. Dhiman

BMC Public Health 20: 1498

Dengue is rapidly expanding climate-sensitive mosquito-borne disease worldwide. Outbreaks of dengue occur in various parts of India as well but there is no tool to provide early warning. The current study was, therefore, undertaken to find out the link between El Niño, precipitation, and dengue cases, which could help in early preparedness for control of dengue. Data on Oceanic Niño Index (ONI) was extracted from CPC-IRI (USA) while the data on monthly rainfall was procured from India Meteorological Department. Data on annual dengue cases was taken from the website of National Vector Borne Disease Control Programme (NVBDCP). Correlation analysis was used to analyse the relationship between seasonal positive ONI, rainfall index and dengue case index based on past 20 years' state-level data. The dengue case index representing 'relative deviation from mean' was correlated to the 3 months average ONI. The computed r values of dengue case index and positive ONI were further interpreted using generated spatial correlation map. The short-term prediction of dengue probability map has been prepared based on phase-wise (El Niño, La Niña, and Neutral) 20 years averaged ONI. A high correlation between positive ONI and dengue incidence was found, particularly in the states of Arunachal Pradesh, Chhattisgarh, Haryana, Uttarakhand, Andaman and Nicobar Islands, Delhi, Daman and Diu. The states like Assam, Himachal Pradesh, Meghalaya, Manipur, Mizoram, Jammu & Kashmir, Uttar Pradesh, Orissa, and Andhra Pradesh shown negative correlation between summer El Niño and dengue incidence. Two - three month lag was found between monthly 'rainfall index' and dengue cases at local-scale analysis. The generated map signifies the spatial correlation between positive ONI and dengue case index, indicating positive correlation in the central part, while negative correlation in some coastal, northern, and north-eastern part of India. The findings offer a tool for early preparedness for undertaking intervention measures against dengue by the national programme at state level. For further improvement of results, study at micro-scale district level for finding month-wise association with Indian Ocean Dipole and local weather variables is desired for better explanation of dengue outbreaks in the states with 'no association.

For further reading: <https://doi.org/10.1186/s12889-020-09609-1>

EPIDEMIOLOGICAL PATTERN OF DOG BITES AND THE OCCURRENCE OF RABIES IN HUMANS WITHIN SRINAGAR DISTRICT OF KASHMIR VALLEY, INDIA

Namera Thahaby, Afzal Hoque Akand, Shabeer Ahmed Hamdani, Abdul Hai Bhat, Syed Akram Hussain, Islamuddin Shiekh, and Sheikh Shubeena

Comparative Immunology, Microbiology and Infectious Disease 73: 101556

Men's dominant ally, best defense defendant, therefore, the pre-eminent peril detector, dogs became a threat for the humanity inflicting a fatal disease of rabies. Dog bites and open garbage dumps became additional and apparent and are serious and sometimes underestimated public health dilemma in the Kashmir region. The aesthetic, primarily health care and psycho-sociological consequences of trauma caused by a dog bites repeatedly burden the standard of lifetime pertaining to the affected persons and their family. The present study was carried in Srinagar district. Diverse sampling plan / data collection strategies were formulated to fulfill the set of objectives. To assess the epidemiological pattern, secondary source of information viz. Shri Maharaja Hari Singh hospital, which shouldered the relevant cases, was utilized. Further, people perception of the subject was assessed using a predesigned interview schedule from respondents selected by appropriate methods. West zone had recorded the highest number of cases (28.95 %), then the south zone, followed by the north zone and the east zone. Majority victims were males (74.27 %) followed by females (25.72 %) [$\chi^2 = 4.442$, $p = 0.219$]. Most of them

belonged to 30-40 (26.88 %) year old groups, followed by 20-30 (22.36 %), 10-20 (16.03 %) and so on. The time of exposure of victims was evening (62.90 %) [$\chi^2 = 30.342$, $p = 0.001$]. The bulk number of cases had bite on legs (56.60 %). Majority had category 3 bites (70.16 %) and the majority had received immunoglobulin (82.85 %) [$\chi^2 = 29.56$, $p = 0.001$]. The summer season (29.30 %) had also recorded the highest number of cases followed by autumn season (27.82 %) irrespective of each determinant. The Anti rabies clinic of SMHS has also recorded two rabies deaths during this period. The majority people (72.50 %) were illiterate and belonging to lower sections of society. About all those diseases that attack humans, rabies is an example of the best known in Srinagar. Its notoriety is peculiar when assessed on its influence medially, on humans who are belonging to the susceptible divisions of the society due to lack of discernment. The lack of complete perception might decipher into higher mortality linked to rabies.

For further reading: <https://doi.org/10.1016/j.cimid.2020.101556>

DIFFERENTIAL BIOACCUMULATION OF SELECT HEAVY METALS FROM WASTEWATER BY LEMNA MINOR

Mohd Asgar Khan, Gowher A. Wani, Humeera Majid, Fajroo Ul Farooq, Zafar A. Reshi, Amjad M. Husaini, and Manzoor A Shah

Bulletin of Environmental Contamination and Toxicology 105: 777–783

The capacity of *Lemna minor* to remediate toxic heavy metals from wastewater is reasonably well documented. In view of the pivotal role of this species in the environmental clean-up, here we evaluated the bioaccumulation potential of *L. minor* for cadmium (Cd), lead (Pb), and nickel (Ni) through a controlled experiment. *L. minor* tolerated the metals Cd, Ni, and Pb up to 0.5, 5, and 8 mg/L, respectively, and beyond these concentrations the toxicity symptoms appeared. Bio-concentration factor varied at different concentrations of heavy metals tested. Overall, *L. minor* showed good phytoremediation potential for all the three tested heavy metals (Cd, Ni, and Pb), though in relative terms it was more effective in extracting Ni and Cd, as compared to Pb, both in single and mixed concentrations. In view of the growing pollution in Kashmir Himalayan aquatic habitats the phytoremediation by invasive species such as *L. minor* promises to be one of the best choices than other native plants for cleaning up of polluted soils/water because of its fast growth rate, high abundance, easy handling, and wide distribution in Kashmir Himalayan aquatic ecosystems.

For further reading: <https://doi.org/10.1007/s00128-020-03016-3>

EMERGING ORGANIC CONTAMINANTS IN GROUNDWATER UNDER A RAPIDLY DEVELOPING CITY (PATNA) IN NORTHERN INDIA DOMINATED BY HIGH CONCENTRATIONS OF LIFESTYLE CHEMICALS

Laura A. Richards, Rupa Kumari, Debbie White, Neha Parashar, Arun Kumar, Ashok Ghosh, Sumant Kumar, Biswajit Chakravorty, Chuanhe Lu, Wayne Civil, Dan J. Lapworth, Stefan Krause, David A. Polya, and Daren C. Goody

Environmental Pollution 268:115765

Aquatic pollution from emerging organic contaminants (EOCs) is of key environmental importance in India and globally, particularly due to concerns of antimicrobial resistance, ecotoxicity and drinking water supply vulnerability. Here, using a broad screening approach, we characterize the composition and distribution of EOCs in groundwater in the Gangetic Plain around Patna (Bihar), as an exemplar of a rapidly developing urban area in northern India. A total of 73 EOCs were detected in 51 samples, typically at ng.L^{-1} to low $\mu\text{g.L}^{-1}$ concentrations, relating to medical and veterinary, agrochemical, industrial and lifestyle usage. Concentrations were often dominated by the lifestyle chemical and artificial sweetener sucralose. Seventeen identified EOCs are flagged as priority compounds by the European Commission, World Health Organisation and/or World Organisation for

Animal Health: namely, herbicides diuron and atrazine; insecticides imidacloprid, thiamethoxam, clothianidin and acetamiprid; the surfactant perfluorooctane sulfonate (and related perfluorobutane sulfonate, perfluorohexane sulfonate, perfluorooctanoic acid and perfluoropentane sulfonate); and medical/veterinary compounds sulfamethoxazole, sulfanilamide, dapson, sulfathiazole, sulfamethazine and diclofenac. The spatial distribution of EOCs varies widely, with concentrations declining with depth, consistent with a strong dominant vertical flow control. Groundwater EOC concentrations in Patna were found to peak within ~10 km distance from the River Ganges, indicating mainly urban inputs with some local pollution hotspots. A heterogeneous relationship between EOCs and population density likely reflects confounding factors including varying input types and controls (e.g. spatial, temporal), wastewater treatment infrastructure and groundwater abstraction. Strong seasonal agreement in EOC concentrations was observed. Co-existence of limited transformation products with associated parent compounds indicate active microbial degradation processes. This study characterizes key controls on the distribution of groundwater EOCs across the urban to rural transition near Patna, as a rapidly developing Indian city, and contributes to the wider understanding of the vulnerability of shallow groundwater to surface-derived contamination in similar environments.

For further reading: <https://doi.org/10.1016/j.envpol.2020.115765>

China Himalaya

CHANGES IN COMMUNITY STRUCTURE AND METABOLIC FUNCTION OF SOIL BACTERIA DEPENDING ON THE TYPE RESTORATION PROCESSING IN THE DEGRADED ALPINE GRASSLAND ECOSYSTEMS IN NORTHERN TIBET

Huiyuan Cheng, Bingde Wu, Mei Wei, Shu Wang, Xinshan Rong, Daolin Du, and Congyan Wang

Science of The Total Environment 755: 142619

The alpine grassland ecosystem in Northern Tibet is seriously degraded. The condition of the degraded alpine grassland ecosystems in Northern Tibet (DAGENT) triggers a serious threat to environmental health and ecological safety of the local society. Thus, restoring DAGENT is a pressing task presently to sustain social stability and sustainable development. Soil microorganisms act a vital role in the structure and function execution of ecosystems. Further, bacteria are sensitive to external disturbances. This study purposes to evaluate the effects of the three types of restoration processing (i.e., the separated plant sowing, the separated water-soluble polyurethane fertilization, and the combined plant sowing and water-soluble polyurethane fertilization) on soil bacterial communities in DAGENT by using high-throughput sequencing with Illumina Novaseq 6000. The separated plant sowing significantly elevations soil pH, and soil nitrogen and phosphorus contents in DAGENT. Additionally, the combined plant sowing and water-soluble polyurethane fertilization markedly improves soil nitrogen content in DAGENT. The combined plant sowing and water-soluble polyurethane fertilization antagonistically affect soil pH and soil phosphorus content in DAGENT. The three types of restoration processing have no obvious effects on the alpha diversity of soil bacteria in DAGENT. But the three types of restoration processing create obvious alterations in the beta diversity of soil bacteria and the relative abundance of soil bacterial proportions in DAGENT. The three types of restoration processing also cause significant modifications in metabolic function of soil bacteria in DAGENT. The leading reason for the altered community structure and metabolic function of soil bacteria may be attributed to the changes in plant growing condition as well as soil pH and nutrient contents in DAGENT. Consequently, the three types of restoration processing are mainly changed the community structure and metabolic function of soil bacteria, rather than the alpha diversity of soil bacteria, in DAGENT.

For further reading: <https://doi.org/10.1016/j.scitotenv.2020.142619>

FAILURE PROBABILITY ASSESSMENT OF LANDSLIDES TRIGGERED BY EARTHQUAKES AND RAINFALL: A CASE STUDY IN YADONG COUNTY, TIBET, CHINA

Lixia Chen, Le Mei, Bin Zeng, Kunlong Yin, Dhruva Pikha Shrestha, and Juan Du

Scientific Reports 10: 16531

Yadong County located in the southern Himalayan mountains in Tibet, China, is an import frontier county. It was affected by landslides after the 2011 Sikkim earthquake (Mw = 6.8) and the 2015 Gorkha earthquake (Mw = 7.8). Casualties and property damage were caused by shallow landslides during subsequent rainfall on the earthquake-destabilized slopes. Existing researches have generally examined rainfall- and earthquake-triggered landslides independently, whereas few studies have considered the combined effects of both. Furthermore, there is no previous study reported on landslide hazards in the study area, although the area is strategically applicable for trade as it is close to Bhutan and India. This study developed a new approach that coupled the Newmark method with the hydrological model based on geomorphological, geological, geotechnical, seismological and rainfall data. A rainfall threshold distribution map was generated, indicating that the southeast part of Yadong is prone to rainfall-induced landslides, especially when daily rainfall is higher than 45 mm/day. Permanent displacement predictions were used to identify landslide hazard zones. The regression model used to calculate these permanent displacement values was 71% accurate. Finally, landslide probability distribution maps were generated separately for dry and wet conditions with rainfall of varying intensities. Results can serve as a basis for local governments to manage seismic landslide risks during rainy seasons.

For further reading: <https://doi.org/10.1038/s41598-020-73727-4>

COMPARATIVE GENOMICS REVEALS EVOLUTION OF A BEAK MORPHOLOGY LOCUS IN A HIGH-ALTITUDE SONGBIRD

Yalin Cheng, Matthew J Miller, Dezhi Zhang, Gang Song, Chenxi Jia, Yanhua Qu, and Fumin Lei

Molecular Biology and Evolution 37: 2983-2988

The Ground Tit (*Pseudopodoces humilis*) has lived on the Qinghai-Tibet Plateau for ~5.7 My and has the highest altitudinal distribution among all parids. This species has evolved an elongated beak in response to long-term selection imposed by ground-foraging and cavity-nesting habits, yet the genetic basis for beak elongation remains unknown. Here, we perform genome-wide analyses across 14 parid species and identify 25 highly divergent genomic regions that are significantly associated with beak length, finding seven candidate genes involved in bone morphogenesis and remodeling. Neutrality tests indicate that a model allowing for a selective sweep in the highly conserved *COL27A1* gene best explains variation in beak length. We also identify two nonsynonymous fixed mutations in the collagen domain that are predicted to be functionally deleterious yet may have facilitated beak elongation. Our study provides evidence of adaptive alleles in *COL27A1* with major effects on beak elongation of *Ps. humilis*.

For further reading: <https://doi.org/10.1093/molbev/msaa157>

COMPARATIVE PHYSIOLOGICAL AND PROTEOMIC ANALYSIS REVEALS DIFFERENT INVOLVEMENT OF PROTEINS DURING ARTIFICIAL AGING OF SIBERIAN WILDRYE SEEDS

Xiong Lei, Wenhui Liu, Junming Zhao, Minghong You, Chaohui Xiong, Yi Xiong, Yanli Xiong, Qingqing Yu, Shiqie Bai, and Xiao Ma

Plants 9: 1370

Seed aging has an important effect on the germplasm preservation and industrialized production of Siberian wildrye (*Elymus sibiricus*) in the Qinghai-Tibet Plateau. However, so far its underlying molecular mechanisms still largely remain unknown. To shed light on this topic, one-year stored seeds of *E. sibiricus* were exposed to artificial aging treatments (AAT), followed by seed vigor characteristics and physiological status monitoring. Then global

proteomics analysis was undertaken by the tandem mass tags (TMT) technique, and the proteins were quantified with liquid chromatography-tandem mass spectrometry on three aging time points (0 h, 36 h and 72 h). Finally, we verified the expression of related proteins by parallel reaction monitoring (PRM). Our results demonstrated that the seed vigor decreased remarkably in response to artificial aging, but the relative ion-leakage and malondialdehyde content, superoxide anion and hydrogen peroxide showed the opposite situation. Proteomic results showed that a total of 4169 proteins were identified and quantified. Gene Ontology (GO) analysis and Kyoto Encyclopedia of Genes and Genomes (KEGG) analysis indicated that a series of key pathways including carbohydrate metabolism, lipid metabolism, and antioxidant activity were severely damaged by aging treatments. Numerous key proteins such as glyceraldehyde triphosphate glyceraldehyde dehydrogenase, succinate dehydrogenase, lipoxygenase, peroxidase, glutathione-s-transferase and late embryogenesis abundant proteins were significantly down-regulated. However, the up-regulation of the heat shock protein family has made a positive contribution to oxidative stress resistance in seeds. This study provides a useful catalog of the *E. sibiricus* proteomes with insights into the future genetic improvement of seed storability.

For further reading: <https://doi.org/10.3390/plants9101370>

Bhutan-Himalaya

POTENTIAL HABITAT DISTRIBUTION OF HIMALAYAN RED PANDA AND THEIR CONNECTIVITY IN SAKTENG WILDLIFE SANCTUARY, BHUTAN

Sonam Tobgay and Nattapon Mahavik

Ecology and Evolution 10: 12929-12939

Survival of endangered Himalayan red panda is threatened by ever-growing anthropogenic activities leading to an unprecedented rate of habitat degradation and loss. However, limited studies have been conducted in the context of the spatial distribution of habitats and habitat connectivity for the species in the landscape of Sakteng Wildlife Sanctuary (SWS). Lack of such information remains a challenge while implementing effective and holistic conservation initiatives. Therefore, this study identifies the distribution of potential habitats and their connectivity using maxent and linkage mapper, respectively. Precipitation-related predictor variables exhibited a significant influence on the prediction of habitat distribution. The model predicted 27.7% of the SWS as a potential habitat (fundamental niche). More than 75% of the predicted habitats fall outside the existing core zones where anthropogenic disturbance is relatively high, indicating the need to reassess existing management options. In SWS, 15 core habitats (CH) are predicted which are connected by a least-cost corridor (length $\mu = 2.91$ km) with several pinch points in it. Centrally located CH5 and CH11 are identified as the most important habitat in maintaining overall connectivity within SWS. However, CH located in the peripheries could be equally important in facilitating the transboundary movement of the species. Overall, SWS can play a critical role as a connecting link between the larger landscape of Bhutan and the adjacent Indian state of Arunachal Pradesh in the conservation of Himalayan red panda that exhibits narrow dispersal with special habitat needs. Based on our findings, we recommend initiating GPS/satellite telemetry of the species to enable SWS to understand the precise interaction of Himalayan red panda to widespread herder communities, livestock, and free-roaming dogs dwelling in the same landscape. It will also help to evaluate the functionality of the predicted habitats, linkages, and feasibility of transboundary conservation initiatives.

For further readings: <https://doi.org/10.1002/ece3.6874>

Highlight of the Issue

NASA's SOFIA discovered molecular water (H₂O) on irradiant lunar surface

NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA) airborne telescope has confirmed the existence of water molecules (H₂O) on one of the largest craters (Clavius Crater) located in the sunlit southern hemisphere of the moon. The astronomical researchers observed that water exists in lunar soil at around 100 to 400 parts per million which is 100 times greater than the amount of water present in the Sahara Desert. Scientists have suggested that lunar water is either trapped in bubbles of lunar glass or likely to be interposed between grains on the lunar surface protecting it from the harsh environment.

For further readings:

<https://www.bbc.com/news/science-environment-54666328>

<https://www.space.com/water-on-moon-shadow-cold-traps-discovery>

<https://www.nasa.gov/press-release/nasa-s-sofia-discovers-water-on-sunlit-surface-of-moon/>