International Symposium

Groundwater Sustainability

Groundwater sustainability based on science and narrative

Makoto Taniguchi (RIHN, Japan)

Abstract

Groundwater is a part of water resources, water environment, water cycle, and water culture with diverse values. Through the histories of the earth, life, human, civilization, colonization, green revolution, industrial revolution, and urbanization, my talk focuses on the linkages, tradeoffs and synergies through groundwater between global and local, benefit and damage, quantity and quality, emergency and normal time, long-term and short-term perspective, far and near, internal and external, individual and collective, and selfishness and altruism. To achieve the sustainable society with groundwater which is invisible, we need making invisible visible through three steps; visualization of the problems (co-design with stakeholders), visualization of processes, and visualization of future vision/design. Groundwater sustainability as well as human well-being will be discussed based on science and narrative.

Groundwater sustainability across scales: from partnering with Indigenous communities to contributing to global initiatives

Tom Gleeson (Univ. Victoria, Canada / Invited Scholar, RIHN)

Abstract

Groundwater resources are the most reliable source of freshwater on the planet, so long as they are sustainably managed. In Canada and around the world a challenge is that groundwater is often forgotten and poorly managed which leads to groundwater depletion and contamination, as well as decreased streamflows that impact ecosystems and culturally important species like salmon. In this interactive presentation, we will consider groundwater sustainability as a social-ecological system across scales starting with an innovative community science project with Indigenous rightsholders and other partners. The 'Xwulqw'selu Connections' project is motivated by perennial concerns of decreasing summer flows in the Xwulqw'selu Sta'lo' and the potential to radically improve water governance and shared management between Indigenous and Settler Governments through the first BC Water Sustainability Plan. Then we'll shift scale to global groundwater sustainability efforts and consider two new quantitative geospatial projects. The first maps archetypes of groundwater social-ecological systems, identifying 10 clearly discernible groundwater system archetypes of groundwater's large-scale socioeconomic, ecological, and Earth system functions using self-organising map methods. The second quantifies the global disease burden of arsenic in groundwater, by compiling robust dataset for training a geospatial machine learning model to predict the occurrence of elevated arsenic globally. Arsenic predications are combined with water use, population, and dose-response relationships to estimate that about 100,000 annual deaths may be attributable to arsenic, such that current estimates of mortality from drinking unsafe water (SDG Indicator 3.9.2) are under-predicted by 10%. In 2022, UN agencies were focused on groundwater and 'making the invisible, visible' which was an opportunity to ensure that groundwater benefits society now and into the future. Throughout

we will discuss science for thriving and equitable social-ecological systems that focus on the connections between groundwater, surface water, people and ecosystems across different scales.

The changing role of groundwater in the global water cycle

Yoshihide Wada (KAUST, Saudi Arabia)

Abstract

Significant impacts of climate change and human activities have been observed on groundwater resources worldwide. These include changes in groundwater recharge, storage and distribution. Climate change has altered groundwater recharge rates, induced greater groundwater contribution to streamflow in glacierized catchments, and enhanced groundwater flow in permafrost areas. Human impacts on groundwater include groundwater pumping, regional flow modification, water table and storage alterations, and the redistribution of embedded groundwater in foods globally. Notably, (nonrenewable) groundwater extraction contributes to sea-level rise, which is still one of the largest sources of the uncertainty in global sea level budget. Groundwater′s role in the global water cycle is becoming more dynamic and complex. Quantifying these changes is essential to ensure availability of fresh groundwater resources for agriculture, industry, households and ecosystem functioning. This talk highlights the current status and future challenges in the changing role of groundwater in the global water cycle.

Recent Developments towards new Groundwater Use in Urban Areas of Japan

Fumi Sugita (Chiba Univ. Commerce, Japan)

Abstract

The urban areas of Japan experienced severe land subsidence due to excessive pumping in the early 20th century. The pumping has been strictly restricted by laws in these areas since then. In recent years, however, citizens, local governments and hydrogeologists have come together to consider using groundwater again in urban areas. Assuring sustainability is crucial hydrogeologists′ role.

Additionally, hydrogeologists have begun to collaborate with the community to improve water quality of urban ponds and lakes, many of which are suffering from eutrophication. Through the collaboration of various actors and experts, groundwater can be the key to the restoration of natural ecosystems and waterfronts in urban areas.

Protecting groundwater resources and dependent ecosystems in water-stressed areas of Eastern England

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Abstract

Water resources in East Anglia, eastern England, are under pressure due to population growth, demand for irrigated crops, environmental requirements and climate change. In this region, an additional 570 × 103 m3 day-1 for public water supply and an estimated 444 × 103 m3 day-1 for other users, including agriculture, power generation and industry, will be needed between 2025–2050. Matching growth with enhanced environmental protection requires innovative solutions and managed aquifer recharge (MAR) offers the possibility of storing excess winter flows underground for later abstraction during periods of peak demand. Given its favourable hydrogeological properties, the Pliocene sand and gravel (Crag) aquifer in Suffolk was selected for a demonstration MAR scheme, with the goal of supplying additional summer irrigation water. The recharge source was a 4.6 km drainage channel that discharges to the River Deben estuary. Trialling the scheme in June 2022, 12,262 m3 of source water were recharged to the aquifer over 12 days via a lagoon and an array of 565 m of buried slotted pipes. Groundwater levels were raised by 0.3 m at the centre of the recharge mound with an approximate radius of 250 m, with no detrimental impact on local water features observed. The source water quality remained stable during the trial with a mean chloride concentration (133 mg L-1) below the regulatory requirement (165 mg L-1). The fraction of recharge water mixing with the groundwater ranged from 69% close to the centre and 5% at the boundary of the recharge mound, leading to a reduction in nitrate-N concentration of 23.6 mg L-1 at the centre of the mound. During July–September 2022, 12,301 m3 of recharge water were abstracted from two, 18 m boreholes to supplement surface irrigation reservoirs during drought conditions. However, the hydraulic conductivity of the Crag aquifer (~10 m day-1) restricted the yield and thereby reduced the economic viability of the scheme. Construction costs for the MAR system were comparatively low but the high costs of data collection and securing regulatory permits brought the overall capital costs to within 18% of an equivalent surface storage reservoir, demonstrating that market-based mechanisms and more streamlined regulatory processes are required to incentivise similar MAR schemes.