THE GLOBAL SAND CRISIS SEMINARS

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Northwestern

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Introduction

In recognition of the growing social, economic and environmental impacts of the global sand crisis, World Wildlife Fund (WWF) and the Institute for Sustainability and Energy at Northwestern University (ISEN) recently partnered to host a series of seminars, convening global experts from across disciplines and sectors to explore solutions. This Call to Action Report distills key recommended action items focused on research, practice, and policy based upon the seminar series presentations and discussions.

After water, sand is the world's second most consumed natural resource at around 50 billion tons per year.¹ Globally, each person uses 18 kg (40 lbs) of sand per day on average.² It is an essential component to our everyday lives. Sand is a central ingredient for the construction of roads, bridges, and buildings. The material is also fundamental in the manufacturing of glass and silicon computer chips.

Yet, amid rising demand, the world is facing a growing sand shortage without readily available alternative materials. Due to grain size and shape, only about 5 percent of global sand and gravel deposits are suitable for use in concrete—found primarily along shorelines and in the beds of rivers and lakes. As the global demand for sand continues to rise faster than natural sources can be replenished, it is crucial to manage this limited resource sustainably.

The global sand crisis is inextricably linked to sustainable development and climate change. Today an unprecedented 57 percent of the world's population—some 4.4 billion inhabitants—live in cities. By 2040, the number of urban residents is projected to rise to 65 percent or nearly 6 billion people.³ With sand and stone making up approximately 70 percent of concrete mixtures, it is unsurprising that surging urbanization is partially responsible for the tripling of the global consumption of sand over the last 20 years.⁴ The

¹ GRID-Geneva, United Nations Environment Programme, 2019, Sand and Sustainability: Finding New Solutions for Environmental Governance of Global Sand Resources, https://unepgrid. ch/storage/app/media/documents/Sand_and_sustainability_UNEP_2019.pdf.

² Ibid.

³ *World Urbanization Prospects: The 2018 Revision*, United Nations, Department of Economic and Social Affairs, Population Division, 2018.

⁴ GRID-Geneva, United Nations Environment Programme, 2019.

growing human migration from rural areas to more densely populated urban centers elevates demand for infrastructure development and for the sand that forms its building blocks. Over the next 20 years, an estimated \$7.5 trillion (USD) is required to meet the growing global demand for infrastructure, approximately double the infrastructure spending that occurred over the previous 20-year period.⁵ In some parts of the world where construction booms have led to dramatic increases in demand for sand extraction, there are increasingly violent social tensions, impacts on human health and livelihoods, and degraded ecosystems.

In addition expanding urban populations causing stress on sand supplies, the built environment must simultaneously be fortified, reconstructed, and re-envisioned in the face of unique threats posed by climate change. Our changing climate continues to fuel the increasing frequency, scale, resulting damage, and recovery costs of world-



The Global Sand Crisis Seminars

- 17 interdisciplinary expert speakers
- 5 seminars
- 600+ attendees from around the world

wide disasters. While concerted efforts are being implemented to meet United Nations targets of cutting global greenhouse gas emissions in half by 2030, national and local governments are increasingly preparing for escalating climactic stressors and seeking mitigation strategies and scalable technologies. In 2017, global economic losses from such catastrophes totaled \$330 billion (USD), which is the second highest loss recorded and is well above the 10-year-average of \$190 billion.⁶ Sand is playing a pivotal role in mitigating these stressors. Rising demand for this limited resource amid dwindling supply is expected to lead to: (1) greater greenhouse emissions connected to its extraction, transport, and use, and (2) increased social and environmental vulnerability.

It is clear that these trends present considerable shifts in our way of life and unique challenges that will require immense investment of labor, capital, natural resources, energy, and ingenuity.

^{5 &}quot;Forecasting Infrastructure Investment Needs and Gaps." *Global Infrastructure Outlook: A G20 Initiative*, https://outlook.gihub.org/.

^{6 &}quot;Swiss Re Sigma Explorer." *Sigma Explorer: Catastrophe and Insurance Market Data*, Swiss Re Institute, 2019, https://www.sigma-explorer.com/.

The Global Sand Crisis Seminars

In recognition of the growing global sand crisis and the need for greater collaboration among researchers and practitioners, World Wildlife Fund (WWF) and the Institute for Sustainability and Energy at Northwestern University (ISEN) partnered to host a series of five seminars, bringing together global experts from across science, engineering, industry, and public policy.

Held virtually in 2021 due to travel restrictions associated with the COVID-19 pandemic, the series explored the latest research, business, and policy perspectives on how increasing concern for reaching our climate and sustainable development goals is affecting the demand, extraction, use, and governance of sand as a global resource. The events emphasized the sharing of knowledge and science, culminating in the identification of better practices and ways forward amid this growing crisis. These "Calls to Action" are at the heart of this report and are detailed herein.

It is important to note that the WWF-ISEN Global Sand Crisis Seminars build upon and complement other publications that have recently emerged in the area of sand sustainability and governance. This notably includes WWF's report "Impacts of Sand Mining on Ecosystem Structure, Process & Biodiversity in Rivers" (2018) as well as the "Sand and sustainability: 10 strategic recommendations to avert a crisis" (2022) and "Sand and sustainability: Finding new solutions for environmental governance of global sand resources" (2019) reports from the United Nations Environment Programme (UNEP) among others.

Seminar Speakers

- Vince Beiser (Keynote Speaker) Award-winning journalist and author of The World in a Grain
- Gary Greenberg, PhD Scientist, Author, Photographer, Inventor
- Pascal Peduzzi, PhD Director at United Nations Environment Programme GRID-Geneva; Professor at University of Geneva
- Kusum Athukorala Chair at NetWwater; Regional Council Member at the Global Water Partnership of South Asia
- Aurora Torres, PhD Postdoctoral Fellow at the Université Catholique de Louvain and Michigan State University
- Mark Simoni Geoscientist for Natural Construction Materials at the Geological

Survey of Norway

- Carlos Santamaria, PhD Professor of Energy Resources and Petroleum Engineering at King Abdullah University of Science and Technology
- Todd Bridges, PhD Senior Research Scientist, Environmental Science; National Lead, Engineering with Nature at U.S. Army Corps of Engineers
- Aaron Packman, PhD Professor of Civil and Environmental Engineering and Director of Center for Water Research at Northwestern University
- Beibei Xu Deputy Director of International Cooperation Department at the China Aggregates Association
- Terri R. Norton, PhD Associate Dean and Professor of Civil & Environmental Engineering at Bucknell University
- Daniel Franks, PhD Professor and Program Leader of Development Minerals at the Sustainable Minerals Institute at the University of Queensland, Australia
- Laura J. Powers Principal Petrographer and Materials Scientist at CTLGroup
- Halinishi Yusuf Managing Director of the Makueni County Sand Conservation and Utilization Authority in Kenya
- Antonis Antoniou Latouros President of the European Aggregates Association
- Deepthi Wickramasinghe, PhD Professor in Zoology and Environment Sciences at University of Colombo, Sri Lanka
- Kate Dawson, PhD ESRC Research Fellow at the London School of Economics and Political Science

Extended biographies of speakers who participated in The Global Sand Crisis Seminars are available in *Annex I*. The names, affiliations, and titles reflected here represent the speakers at the time of their participation in the seminars. While all speakers were involved in the drafting of this Call to Action Report, inclusion of their name does not necessarily signify their or their organization's endorsement of the Report recommendations.

Watch The Global Sand Crisis Seminars

Online recordings of The Global Sand Crisis Seminars are available in *Annex II*.

Calls to Action

Following The Global Sand Crisis Seminars, expert speakers and event organizers distilled the most pressing takeaways from the workshops into **Calls to Action**, which are laid out here. These Calls to Action provide clear guidance for three sectors that play an essential role in understanding and addressing the growing global sand crisis—those sectors focused on **research, practice, and policy**. To make true impact, it is crucial that these sectors collaborate with one another and quickly mobilize around this actionoriented framework.



Research Sector

Definition: Research plays a critical role in the creation of new knowledge and laying the groundwork for sustainable solutions. The intended audience for these calls to action include universities, colleges, national laboratories, government research agencies, and civil society organizations among others.

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Link natural and human systems to promote sustainable land use including:

- Improving understanding of relevant natural systems: Map and quantify geological deposits, flows, dynamics of sediment transport, spatially distributed sand extraction rates, sand budgets for watersheds/regions, and stream morphology and types of sands, with differentiation between static and dynamic environments.
- Assessing trends in human sand usage and developing a spatial representation of the supply network: Spatial and temporal patterns of demand and stock changes of construction aggregates within a region over time, extraction sites and transport networks and markets, historical demand/supply patterns and stakeholders, alternative and secondary material stocks, and spatially distributed demand estimates for construction aggregates.



Analyze socioeconomic impacts of sand extraction, transport, and use across scales and sites to determine the:

- Impact on human migration patterns
- Impact on infrastructure (e.g., roads, bridges, water intakes, housing)
- Effects of saltwater intrusion and coastal erosion, impacting water intakes, agriculture, drinking water, and community livelihoods
- Impacts of lower groundwater table on water scarcity
- Heterogeneous distribution of social-economic impacts of sand extraction (e.g., on vulnerable groups including artisanal and small-scale miners and women) and related issues of sedimentary justice, defined as the direct relocation of sediment from one place to another or through the colonial extraction of territory
- Environmental strategic role of sand for communities (e.g., shoreline protection/health, aquifers, etc.)
- Impact on community resilience in the face of environmental disasters and extreme weather
- Positive community impacts associated with a sustainable sand economy

O3 Expand limited investigations of the ecological impacts of sand extraction to include loss and degradation of habitats/biodiversity, indirect impacts, effect on animal migration patterns, threats to sensitive species including extinction risks, impacts on food webs with particular focus on freshwater and marine environments. Expand studies on invertebrates, which is currently particularly lacking.

Improve the state of technology transfer from the lab to industry. The development of alternative and novel aggregates and less sand-intensive methods are necessary to adequately address the sand crisis and adapt to the local geological and socio-ecological contexts. While there are many research papers on alternative aggregates, the process of transitioning alternatives from basic research to practical use has been slow. Environmental and safety impacts of alternative aggregates should be examined.

D5 Improve understanding of links between sand extraction and climate change. To what extent are the negative impacts of sand extraction exacerbated by climate change? How will climate change affect sand demand/supply in the coming decades? How is sand utilized in climate resiliency efforts, and what is the impact on the global sand economy? How can these trends be predicted, measured, tracked, and remedied where necessary?

Practice Sector



Definition: The Practice sector includes those members of society who build and implement the world's sand management systems. This sector includes construction professionals and educators (e.g., architects, purchasing managers, trade schools), industry actors (e.g., contractors, suppliers,), construction regulators (e.g., those responsible for issuing building permits), and civil society organizations (e.g., global advocacy

organizations, humanitarian organizations, development agencies, local community organizations) among others. It is important to note that different regions of the world may use slightly different terminology for members of this sector.

Closely evaluate trade-offs between the extraction of sand from static environments (e.g., quarries) and dynamic environments (e.g., rivers) and factor these trade-offs into decision making. It is necessary to integrate natural sand budgets, regional material flow analyses of the construction aggregate system, supply and demand projections, and environmental system science into sustainable sand use planning. This will also support sand supply chain diversification, provide alternative methods, and make supply networks more resilient to unforeseen changes in demand, resource availability, and prices.

Industry players should prioritize creating specifications and standards for reused and recycled materials and provide guidance on how to use them. Alternative materials will not be used unless they are affordable, available, technically sound, and recognized as safe. Cost, availability, and compliance with national standards are major concerns for the industry.

Restructure professional education/training and prioritize education of the general public on these issues. Redesign professional curricula and training around construction materials/engineering with renewed focus on interlinkages between natural and human material systems, material flow analysis, environmental impact assessments, modernized building standards and codes, and product certification/ sustainable sourcing. In terms of educating the general public, drawing the link between sand extraction and water security, biodiversity, and economic/social impacts could be beneficial as an angle to raise awareness on the sand crisis.

Prioritize on-site recycling of materials, such as reusing unneeded material excavated during construction, incinerator bottom ash, the co-production of sand and gravel in the mining process (e.g., ore-sand), and other processes. The co-production of sand and metals in order to reduce mine tailings shows especially high promise as a sand alternative since it tends to be similar to manufactured sand (also known as crushed rock). Consider the use of secondary resources such as recycled concrete, asphalt, and railway ballast and the re-purposing/recycling of materials from abandoned buildings (i.e., construction and demolition waste). Note that while the use of recycled concrete in the industry can be expanded, it is unlikely to entirely replace fresh concrete because its physical properties are quite different from the original material.

Where the use of sand and concrete is irreplaceable, adopt material efficiency strategies in the construction sector to minimize sand demand (e.g., reduce on-site waste of sand/concrete, better storage, use of pre-caste items in-place of on-site casting of concrete, more efficient design).



Policy Sector

Definition: Strategic, clear, and effective public policy is crucial for creating a framework for successfully addressing the global sand crisis. The Policy sector includes government agencies and legislatures (at the national, regional, and local levels), international policy-making bodies

(e.g., the United Nations), environmental management authorities (e.g., water, forestry, ecology), land use planning organizations (e.g., geological survey agencies, city planning organizations), financial institutions, civil society organizations, and measurement/ standards authorities among others.

There should be an international institution (or regional institutions) that monitors how much sand is used, determines where it originates, collects promising solutions, and evaluates the effectiveness of various regulatory policies (or lack thereof) around the globe.

At a national level, cultivate integrated resource-based planning for sustainable sand extraction and incorporate considerations of equity and sedimentary justice. Project the future growth in construction and corresponding quantity and location of demand for sand. Integrate sand management into land management policies, including through monitoring and enforcement of sand extraction permitting, laws, and regulation.

Prior to extraction, it is critical for public policy to require a comprehensive strategic environmental assessment to understand if and how sand can be extracted from a particular location in order to minimize the environmental impact on biodiversity, fisheries, and tourism as well as hydrodynamic influence, including those related to agriculture and drinking water. Environmental impact monitoring and reporting should occur throughout a project's duration.

Construction regulatory regimes should require a regular review of standards for construction methods and materials, taking into consideration new technologies and approaches. This is to ensure that standards are performance-based and that best practices are identified and adopted more quickly, without compromising safety. Educating professionals on novel approaches is important, and the industry may be hesitant to examine alternatives unless policy dictates that they do so. Similarly, antiquated regulations, standards, and codes of practice often act as major barriers to the widespread use of alternative materials and aggregates.

Policy makers should give focused attention to the growing global demand for basic infrastructure construction as well as the increasing rate of human migration from rural to urban areas in coming years, both of which will increase demand for sand (e.g., for expanded infrastructure development). Climate change will compound these pressures as communities fortify and rebuild amid growing frequency of extreme weather events. It is important for all levels of government to anticipate these changes and incorporate them into economic and regional planning.

Innovations in Sand Governance: Makueni County, Kenya

Local community engagement is essential to understand the social/ economic impacts of sand extraction practices and policies. A federalist approach where a national government sets broad standards for local/ provincial authorities to interpret and implement is important. Consider formation of local sand governance authorities to carry out such standards. Borrow lessons learned from local and community-led sand governance such as in Makueni County, Kenya where they:

- Coordinate and supervise the construction of sand dams in designated conservation and utilization sites.
- Designate sites for sand harvesting to allow for co-existence and prioritization of competing uses for the sites. For example, mark where local communities are harvesting water to indicate that sand cannot be harvested in that location or mark a certain area as buffer zones.
- Formally reserve a percentage of revenues from sand extraction to be used for restoration activities to aid recovery of harvested sites.
- Designate access roads and ensure that trucks use designated access roads only to reach sand utilization sites.
- Recommend areas for rehabilitation, areas for conservation, and areas to use for sand harvesting.
- Implement a co-management approach to sand management that involves both government officials and local community members.





Photos: Makueni County, Kenya (© Halinishi Yusuf)

Annexes

I. Global Sand Crisis Seminar Speaker Biographies

The following biographies were current at the time of The Global Sand Crisis Seminars but may not reflect recent changes.

Vince Beiser – Award-winning journalist and author of The World in a Grain

Vince Beiser is an award-winning journalist and author of "The World in a Grain: The Story of Sand and How It Transformed Civilization." The book was a finalist for a 2019 PEN America award and a California Book Award, and has been translated into five languages.

Vince has reported from over 100 countries, states, provinces, kingdoms, occupied territories, no man's lands and disaster zones. He has exposed conditions in California's harshest prisons, trained with troops bound for Iraq, ridden with the first responders to natural disasters, and hunted down other stories from around the world for publications including Wired, The Atlantic, Harper's, Time, The Guardian, Mother Jones, Playboy, Rolling Stone, The Los Angeles Times, The Wall Street Journal, and The New York Times.

Vince's work has been honored by Investigative Reporters and Editors, the Society of Professional Journalists, the American Society of Journalists and Authors, the Columbia, Medill and Missouri Graduate Schools of Journalism, and many other institutions. He has three times been part of a team that won the National Magazine Award for General Excellence, and shared in an Emmy for his work with the PBS TV series SoCal Connected. He is also a grantee of the Pulitzer Center on Crisis Reporting.

Gary Greenberg, PhD - Scientist, Author, Photographer, Inventor

Scientist, author, photographer, and inventor, Gary Greenberg lives in Maui, Hawaii where he combines the tools of art and science to explore Nature. He earned a PhD in developmental Biology from University College London. During the 1980's, Dr. Greenberg was an Assistant Professor at the University of Southern California, where he worked as a researcher and cell biology teacher. In 1990's, he began developing unique three-dimensional microscopes for research, biomedicine and industry. He has been issued 20 US patents for microscope devices and methods. He founded the company Edge-3D, which innovates and develops 3D microscopes and microscope software. He has written two books about sand through the microscope, A Grain of Sand: Nature's

Secret Wonder (2008), and The Secrets of Sand (2015).

Pascal Peduzzi, PhD – Director at United Nations Environment Programme GRID-Geneva; Professor at University of Geneva

Pascal Peduzzi is the director of GRID-Geneva, the centre for analytics oft the United Nations Environment Programme (UNEP). He holds a PhD in Environmental Sciences and is part-time professor at the faculty of Sciences, University of Geneva. He is the author of various scientific publications and provided numerous conferences to governments, media and the general public to raise awareness on the consequences of human impacts on the environment. In 2014, he wrote a UNEP foresight report entitled "Sand rarer than one thinks", this publication raised the awareness on the issue of sand and environmental impacts. In 2019, he coordinated the production of a UNEP report on sand and sustainability. This report led to the adoption of a resolution at UNEA-4 on mineral resource governance, including on a special focus sand. Currently he added a team dedicated to research on sand and sustainability in his centre.

Kusum Athukorala – Chair at NetWwater; Regional Council Member at the Global Water Partnership of South Asia

Kusum Athukorala holds a M.Sc in Managing Rural Change, Imperial College, University of London. As multidisciplinary skilled development professional, and Founding member of the Saciwaters consortium she has been internationally recognized for work in gender and water; she is the recipient of the International Water Association's International Women in Water Award and the Zonta Woman of Achievement for Environment. Working on advocacy from global to local level as sustainability advisor, development consultant and gender resource person for a range of national and international organizations , her work is extensively cited in peer reviewed journals.

A former academic, she has pioneered establishing and growing an array of national and international organizations related to water management such as the Global Water Partnership, SaciWATERS, Women for Water Partnership and NetWwater. She promotes women and youth as catalysts for change, supports community engagement for integrated water management and produces documentaries related to water.

Aurora Torres, PhD – Postdoctoral Fellow at the Université Catholique de Louvain and Michigan State University

Aurora Torres is a Marie Sklodowska-Curie postdoctoral fellow at the Université Catholique de Louvain of Belgium and the Center for Systems Integration and Sustainability at Michigan State University. She developed her PhD in Ecology at the Spanish Museum of Natural History. She currently coordinates the SANDLINKS project funded by the European Union's Horizon 2020 research programme that integrates, tests and quantifies the main linkages between sand use, environmental pressures and socioeconomic outcomes.

Mark Simoni – Geoscientist for Natural Construction Materials at the Geological Survey of Norway

Mark Simoni is a research scientist for natural construction minerals at the Geological Survey of Norway, NGU. He has a background in economic geology, civil engineering, and industrial ecology, and works with mixed methods including geological field mapping, GIS, mineral resource classification and material flow analysis to identify and safeguard suitable mineral deposits for future construction aggregates mining, and to analyse various aspects of material supply chains for better resource governance across the entire anthropogenic material system.

Carlos Santamaria, PhD – Professor of Energy Resources and Petroleum Engineering at King Abdullah University of Science and Technology

J. Carlos Santamarina graduated from Universidad Nacional de Córdoba and completed graduate studies at the Universities of Maryland and Purdue. He taught at NYU-Polytechnic, the University of Waterloo and at Georgia Tech before joining KAUST in 2015. His research centers on the science of geomaterials and engineering solutions to address global energy challenges, with contributions from resource recovery to energy and waste geostorage. He delivered the 50th Terzaghi Lecture on Energy Geotechnology, was a British Geotechnical Association Touring Lecturer, and is member of both Argentinean National Academies. Former team members are professors at more than forty universities, researchers at national laboratories, or practicing engineers at leading organizations worldwide.

Todd Bridges, PhD – Senior Research Scientist, Environmental Science; National Lead, Engineering with Nature at U.S. Army Corps of Engineers

Todd Bridges is the U.S. Army's Senior Research Scientist for Environmental Science. He leads innovation in the areas of sustainable infrastructure and environmental management for the U.S. Army and the Army Corps of Engineers (USACE). Todd is the National Lead for the USACE Engineering with Nature® initiative which began in 2010 to advance the use of nature-based solutions through a combination of research, field application, and strategic communication.

Aaron Packman, PhD – Professor of Civil and Environmental Engineering and Director of Center for Water Research at Northwestern University

Aaron Packman is Professor of Civil and Environmental Engineering and Director of Center for Water Research at Northwestern University. He is an internationally recognized expert in water resources, surface-groundwater interactions, and biological and biogeochemical processes in aquatic systems. His current research focuses on water systems dynamics, contamination risks, and microbial growth and transmission in natural and engineered water systems.

Packman's research team is working to solve a variety of problems, including nutrient pollution, urban flooding, ecosystem degradation and restoration, and waterborne disease transmission. Packman has received numerous awards and honors, including a Fulbright Distinguished Chair in Hydrology and Hydraulic Engineering, the Huber Research Prize from the American Society of Civil Engineers, and research Career Awards from the National Science Foundation and National Institutes of Health. He received a BS in Mechanical Engineering from Washington University in St. Louis, and an MS and PhD in Environmental Engineering and Science from the Caltech.

Beibei Xu – Deputy Director of International Cooperation Department at the China Aggregates Association

Xu Beibei is the Deputy Director of International Cooperation Department of China Aggregates Association (CAA), which is a non-profit social organization based in Beijing. Her job is to promote communication and exchange between CAA and relevant international organizations.

Terri R. Norton, PhD – Associate Dean and Professor of Civil & Environmental Engineering at Bucknell University

Terri R. Norton is the Associate Dean for Students and Strategic Initiatives and a Professor of Civil & Environmental Engineering at Bucknell University. She is also the Executive Director of the Engineering Success Alliance. Professor Norton's technical expertise is in the area of structural dynamics and structural vulnerability. Her research interests involve evaluating the effects of hazards on civil structures, debris management, and disaster reconstruction. Previously, she enjoyed a distinguished 11-year tenure at the University of Nebraska-Lincoln (UNL). She was a Fulbright Research Scholar in Japan for her research on debris management and reconstruction following the 2011 Great East Japan Earthquake and Tsunami (GEJET). Professor Norton has served as the PI on grants funded by the National Science Foundation (NSF), the US Geological Survey (USGS), the Nebraska Department of Roads (NDOR), and the Department of Energy (DOE). She is an elected member of the Earthquake Engineering Research Institute's (EERI) Board of Directors and is an invited member of the National Academies of Sciences, Engineering and Medicine Resilient America Roundtable.

Daniel Franks, PhD – Professor and Program Leader of Development Minerals at the Sustainable Minerals Institute at the University of Queensland, Australia

Daniel Franks is known internationally for his work on the interconnections between minerals, materials and sustainable development, with a particular focus on the role of minerals in poverty reduction and the social and environmental change associated with mining and energy extraction. Daniel's work spans the governance of artisanal, small-scale and large-scale mining. While metals and gemstones are a feature of his research, he especially focused on industrial minerals, construction materials and other 'Development Minerals' that are mined and used for local and domestic development. These later minerals matter in our efforts to achieve the ambitious Sustainable Development Goals, because they are literally the matter that underpins much of global development, whether it be the clay bricks and roof tiles that provide shelter, the mineral fertilizers fundamental for agriculture, the garnet that filters water, or the gravel and stone that builds bridges and paves rural roads.

Laura J. Powers – Principal Petrographer and Materials Scientist at CTLGroup

Laura Powers is a principal petrographer and materials scientist at CTLGroup in Skokie, Illinois. She has provided analytical support to the construction industry and the mining industry for over three decades where her investigations of concrete and its constituents have been a critical part of engineering evaluations of concrete performance. She has also participated in research into the use of alternative constituents for making concrete. Laura is an active member of the standards organization ASTM International and professional organizations that include the American Concrete Institute, Geological Society of America, and others.

Halinishi Yusuf – Managing Director of the Makueni County Sand Conservation and Utilization Authority in Kenya

Halinishi Yusuf is the Managing Director of the Makueni County Sand Conservation and Utilization Authority, a Corporation of the County Government of Makueni in Kenya She has been in charge of sand matters in the County for 4 years now. She has a wealth of experience in natural resource management including forestry, fisheries, water, sand and cross cutting issues of climate change. Ms. Yusuf holds a Bachelor's degree in Environmental Studies from Kenyatta University and a Master of Arts in Development Studies, specializing in Environment and Sustainable Development from the International Institute of Social Studies- an Institute of the Erasmus University, Rotterdam.

Antonis Antoniou Latouros – President of the European Aggregates Association

Antonis Antoniou Latouros was elected President of UEPG in June 2021 and since 2018 used to be the 1st Vice President of UEPG. He is also the President of the Cyprus Aggregates Producers Association since 2013 for which he used to be the Vice President for the years 2007 to 2013.

Antonis Antoniou Latouros has extensive experience in the aggregates industry, being the CEO of M.S.C. Latouros Investments Ltd, the largest quarry group in Cyprus consisting of three aggregate quarries (Latomia Latouros Ltd, Latomio Pyrgon Ltd, Elmeni Latomia Ltd) and one gypsum quarry (Latouros Gypsum Ltd). In the group also operates a construction & demolition waste recycling plant (Recycling Point Ltd) as well as a holistic chemical laboratory (Veltia Cyprus Ltd).

He is also a Board member and chairs the Audit Committees of the public companies, The Cyprus Cement Public Company Ltd, K & G Complex Public Company Ltd and CCC Tourist Enterprises Public Company Ltd and he was also

Board Member (2012-2015) and Chairman (2015-2017) of The American Academy Alumni Foundation.

Deepthi Wickramasinghe, PhD – Professor in Zoology and Environment Sciences at University of Colombo, Sri Lanka

Deepthi Wickramasinghe is a Professor in the Department of Zoology and Environment Sciences at the University of Colombo, Sri Lanka. She studied at the University of Colombo and Dalhousie University, Canada where her dissertation on biodiversity conservation earned her a Ph. D in 2003. She was the President of the Institute of Biology, Sri Lanka in 2010. Deepthi has a strong commitment towards biodiversity conservation with her work primarily in research, public outreach and international networking. Her research interests include wetlands, nature based solutions and sustainability. She serves in many local and international committees, associations and working groups on environment, water and disaster resilience.

Kate Dawson – ESRC Research Fellow at the London School of Economics and Political Science

Kate Dawson is an ESRC Postdoctoral Fellow at LSE's Department of Geography and Environment. Her research examines the socio-natural politics of cities and resources, focusing specifically on sand.

II. Global Sand Crisis Seminar Online Recordings

- Seminar 1 "Setting the stage: What is so special about sand and why are we on the verge of a global crisis?" — <u>View the event recording</u>
- Seminar 2 "Incentives for sustainability: Toward better management standards, practices, and norms" <u>View the event recording</u>
- Seminar 3 "The future of sand: Is technology the answer?" <u>View the event</u> recording
- Seminar 4 "Equity, Ecosystems and Scarcity: The Global Sand Crisis and Infrastructure" special session sponsored jointly with the United Nations Environment Programme (UNEP); recorded live at the 2021 IUCN World Conservation Congress — <u>View the event recording</u>
- Seminar 5 Moderated capstone discussion with keynote Vince Beiser, joined by expert panelists from the prior sessions — <u>View the event recording</u>

