GSES SUMMER SCHOOL 2021

International Environmental Leadership Program (IELP)

International Joint Graduate Program in Resilience and Safety Studies (GP-RSS)

Graduate School of Environmental Studies (GSES)

"Environmental Sustainability from Energy, Resource, and Resilience Perspectives"

TOHOKU UNIVERSITY

September 6-8, 2021

Online meeting link (Zoom):
https://bit.ly/gses2021

(prior registration required by accessing the link below
http://www.kankyo.tohoku.ac.jp/summerschool/)

Zoom meeting QR code

GSES School of Environmental Studies Graduate

IELP International Environmental Leadership Program

GP-RSS International Joint Graduate Program in Resilience and Safety Studies

CONTACT US gses-summerschool@grp.tohoku.ac.jp
(Summer School Secretariat, GSES)

GSES SUMMER SCHOOL 2021

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September 6-8, 2021

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Noriyoshi TSUCHIYA, Ph.D.
Professor
Dean of Graduate School of Environmental Studies
Tohoku University, Japan

Guest Lectures

Yuko SAITO, Ph. D
Associate Professor, Graduate School of Environmental Studies
Tohoku University, Japan
Title: "Resource Circulation: A Case Study of E-waste"

Seeram RAMAKRISHNA, Ph.D., TGMP
Professor, Department of Mechanical Engineering
The National University of Singapore, Singapore
Title: "Build Back Better Materials World to Deal with the Existential Threats to Humanity - Reimagine Materials"

Angela RAVEN ROBERTS, Ph.D.
Researcher, Department of Education
University of Oxford, UK
Title: "Risk and Resilience in the Post Pandemic Era Ethiopia as a Case Study"

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Professor, Research School of Earth Sciences
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Tsinghua University, China
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Professor, Geography and Spatial Sciences
University of Delaware, USA
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Guido GRAUSE, Ph.D.
Associate Professor, Graduate School of Environmental Studies
Tohoku University, Japan

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SCHEDULE

Import events to your Google Calendar
https://bit.ly/gses2021events

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Day 1, September 6, 2021 (Monday)
Time: 14:30 - 16:00 JST

Guest Speaker

"Resource Circulation: A Case Study of E-waste"

Yuko SAITO, Ph.D.
Associate Professor, Graduate School of Environmental Studies
Tohoku University, Japan

BIO

Yuko Saito, Ph.D. obtained her Phd from Tohoku University in 2013. She received Research Fellowship from the Japanese Society for the Promotion of Science from 2014 to 2016 and later worked as a Specially Appointed Assistant Professor from 2016 to 2020 at the Graduate School of Environmental Studies, Tohoku University. She is currently an Associate Professor at the same graduate school. Her research interests include plastic recycling, resource recycling society system, environmental policy, waste policy, and resource recycling policy.

ABSTRACT

Resources can be categorized as primary or secondary resources. Primary resources are metals and energy and so on resources mined from the natural world. Secondary resources are resources obtained from products that are used and discarded in society. The effective utilization of secondary resources is closely related to recycling technologies and social systems, which vary greatly from country to country and region to region. In this session, we will consider the status of the resource recycling system in Japan by comparing the European Union and Japan using a case study of E-waste (waste electrical and electronic equipment; WEEE).

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Day 1, September 6, 2021 (Monday)
Time: 16:00 - 17:30 JST

Guest Speaker

"Build Back Better Materials World to Deal with the Existential Threats to Humanity - Reimagine Materials"

Seeram RAMAKRISHNA, Ph.D., TGMP
Professor, Department of Mechanical Engineering
The National University of Singapore, Singapore

BIO

Seeram Ramakrishna, Ph.D., TGMP, is Professor of Mechanical Engineering and the Chair of the Circular Economy Taskforce at the National University of Singapore (NUS). He is among the top four researchers at the NUS, and among the top six researchers of Singapore. Highest professional distinctions include an elected Fellow of UK Royal Academy of Engineering (FREng); American Association of the Advancement of Science (AAAS); and many more. He received PhD from the University of Cambridge, UK; and the GMP training from Harvard University, USA. He was identified among the World's Most Influential Scientific Minds (Thomson Reuters) and the Top 1% Highly Cited Researchers in the world in materials science and cross-fields categories (Clarivate Analytics). Microsoft Academic ranked him among the top 50 authors. He published book "Sustainability for Beginners", Springer Nature book on Circular Economy and far more. You can read his full bio, LinkedIn, Google Scholar, and website.

ABSTRACT

Inspired by the concern for humanity, authors of 1972 book The Limits to Growth professed problems affecting the habitability of planet Earth for today's as well as future generations. Since then they were further refined and articulated. More recently, in the form of United Nations seventeen Sustainable Development Goals, SDGs. Sustainability is about reduction of greenhouse gas emissions as well as circular solid waste management to reduce environmental pollution and waste accumulation in the nature, to protect human health, to alleviate resources depletion and environmental deterioration, to regenerate biodiversity, and to overcome rising sea levels and extreme weathers caused by climate change for the well being of humans and preserving Earth for the future generations. The climate change articulation gained the attention of many people. And yet only a small fraction of humanity as well as capital investors are prepared to act on the sustainability solutions. Thus, sustainability articulations in the name of carbon neutral economy, low-carbon economy, circular economy, and science based sustainability targets with the promise of quality living conditions, jobs and economic growth, are advocated by the governments and captains of industry. There are many facets and dimensions to myriad articulations. Materials are central to the humanity's sustainability efforts. According to recent papers published in the Nature journals, about 23% of global emissions can be attributed to materials production, and the global human made mass now exceeds all living biomass of Earth. It is implicit to reimagine materials or build back better materials world so as to mitigate the existential threats to the humanity i.e. environmental degradation and biodiversity loss.

Materials - Emissions and Waste Burden

Modern human life is built on materials advancements and exponential consumption of them. Materials development over the past three centuries is aimed at meeting the cost and functional performance requirements, and searching for special or unique material properties observed never before. This can be evidenced by the significant research investments in recent years to conceive high performance materials and intelligent materials. Materials education at more than 20,000 higher education institutions around the world is focused on theories and classification of materials, processing-microstructure-property relationships, and applications. Infusing materials education with sustainability aspects is recent, and only taking place at a small number of universities. Lack of suitable text books and core scientific principles are often cited reasons for this situation. Going forward this is untenable as the humanity is hard-pressed to mitigate existential threats. Hence, mainstreaming of materials sustainability education is necessary and important.

ABSTRACT (continued)

Nature of materials in the generation of emissions and waste is underestimated. Henceforth, the materials research and innovations should also be aimed at lowering the carbon footprint of materials and enhancing the circulaty of materials. This calls for reimagining materials from atoms and molecules, as well as harnessing nanoscience, single atom science, and quantum science. They are in addition to eco friendly design and materials efficiency of products, low carbon materials from renewable and local sources, resources efficient processes, more circular end of life waste management practices while not sending waste to the poorer communities, and switching to renewable energies to eliminate or reduce the waste and emissions at all stages. Furthermore, the traditional knowledge of materials laced with sustainability by the former civilizations has been either ignored or lost. It is valuable to systematically investigate and document the traditional knowledge of materials around the world and integrate it with the modern science and engineering of materials.

Chemicals - Health Burden

A common thread of UN SDGs is human health and wellbeing. The World Health Organization (WHO) reports suggest that human milk or breast milk is the best source of nutrition for infants, and furthermore, imparts enhanced protection from chronic diseases such as asthma and diabetes and mental health resilience in the adulthood too. Unfortunately, contamination of human milk with toxic chemicals and heavy metals are reported around the world. Chemicals found in drugs and manufactured materials and products enter the human body via all routes, which include ingestion, dermal exposure and inhalation. Chemicals accumulation in human tissues may disrupt the interdependent organ systems of human body. For example, the endocrine disrupting chemicals or EDCs may be one of the reasons for declining fertility rates in Europe, USA, China, Japan, South Korea and Singapore. The average birth rate of Singapore was 5.8 in 1959 and now it is 1.1. The current fertility rates of USA, Japan, China, and South Korea are 1.6, 1.34, 1.3, and 0.84, respectively.

Most chemicals come to widespread use based only on their technical, availability and cost performances. The vast majority of these, however, were never tested for unintended human side-effects. Henceforth, aim scientific research to develop human health friendly chemicals. Sustainable or green chemistry and adequately tested safe chemicals should only be allowed to enter market so as to ensure the resiliency of humanity. Efforts must be made to anticipate the human side-effects, and forestall health burden prior widespread introduction of new chemicals and materials.

A clarion call to millions of researchers worldwide to reimagine materials or build back better materials and tackle triple expectations of future materials together i.e. enhanced functional performance, sustainability performance, and zero-negative health effects. Ultimately, materials should not be the bottleneck for ensuring the sustainability of humanity.

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Day 1, September 6, 2021 (Monday)
Time: 17:30 - 19:00 JST

Guest Speaker

"Risk and Resilience in the Post Pandemic Era Ethiopia as a Case Study"

Angela RAVEN ROBERTS, Ph.D.
Researcher, Department of Education
University of Oxford, UK

BIO

Angela Raven Roberts, Ph.D. is an independent researcher with 30 years' global experience with United Nations, NGOs, and universities specializing in humanitarian protection, resilience building and assistance to marginalized populations, risk and vulnerability analysis in complex emergencies, etc. She holds a Ph.D. in Anthropology from the University of Minnesota, a Master's degree in Social Anthropology from Oxford University, and a Bachelor's degree in African History and Social Anthropology from London University School of Oriental and African Studies. Her research interests include gender and governance, youth and childhood in emergencies; education, citizenship, and post-crisis recovery; pastoral livelihoods in change; community-based risk reduction systems; role of national civil services in disaster preparedness and post-crisis recovery.

ABSTRACT

The Covid-19 pandemic was experienced as the greatest structural 'shock' since World War II posing many challenges to social protection systems and paradigms of development across the globe. It has also raised recurring questions on the ability of governments and institutions to respond to global pandemics and other risk hazards with a potential for affecting multiple communities and countries at the same time. The emergence of a new hazards such as climate change and now pandemic such as COVID-19 have renewed calls for a re-thinking of resilience building, preparedness and the integration of anticipatory shock responsive mitigation measures into all aspects of economic and social development. This talk will review the ways in which risk and resilience have been defined and informed development policies in the context of the multiple hazards facing the country. Ethiopia is a country with a diverse population of 112 million people practicing a range of livelihood systems adapted to different ecological and environment settings. These systems have been and continue to be exposed to climate change which has different impacts according to each region and geographical zone. These issues are also intertwined with a history of conflict and governance volatility and transitions which continue to this day. Set against these 'uncertainty frameworks' the talk will examine commonly defined international agency concepts of resilience such as ***'the abilities of countries, communities and households to manage change by maintaining or transforming living standards in the face of shocks and stresses such as earthquakes, drought or conflict without compromising long term prospects'*** *(DFID, UK.Gov)* and explore how and whether this remains appropriate to the economic, cultural, spiritual and psychological challenges and needs Ethiopian communities are facing today.

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Day 2, September 7, 2021 (Tuesday)
Time: 13:30 - 15:00 JST

Guest Speaker

"Involvement of Fluids and Seismicity in Energy Production and Mineral Resource Formation"

Stephen F. COX, Ph.D.
Professor, Research School of Earth Sciences
Australian National University, Australia

BIO

Stephen F. Cox, Ph.D.received his PhD from Monash University, Australia. Currently an Emeritus Professor in Research School of Earth Sciences at Australian National University. His research interests involve deformation processes in the Earth, particularly the links between crustal deformation processes, crustal strength, fluid transport, and ore genesis in deforming rocks. He conducts a mix of experimental, field-based, microstructural, and modeling studies.

ABSTRACT

My lecture will discuss some processes associated with the migration of high-pressure fluids through rocks at depth in the Earth's upper crust. **Firstly**, I will show you that injection of pressurised fluids into low permeability rocks typically generates seismic activity. We will see that this seismicity is different from the mainshock-aftershock type of seismicity that many of you may have experienced Involvement of fluids and seismicity in energy production and mineral resource formation. Fluid injection typically generates swarms of mostly small earthquakes. Engineered injection experiments mostly have durations of days and comprise sequences of thousands to tens of thousands of microearthquakes. Natural, injection-driven earthquake swarms are identical to engineered injection experiments, but can last for periods ranging from a few days to a few years. I will illustrate recurring, natural swarm seismicity from Hakone caldera. In this case, the source of deep pressurised H2O/CO2 fluids is a magma chamber deep beneath Hakone volcano.

I will give you examples of engineered, deep fluid injection experiments that were conducted for geothermal energy exploration and production in Australia and Europe. We will explore why these experiments have, so far, failed as a source of sustainable energy production. We will also note various other applications and hazards associated with deep injection, or "fracking" processes, performed for enhanced hydrocarbon recovery, natural gas production from "tight" shales, CO2 sequestration and wastewater disposal. We will see how fluid injection can apparently trigger larger than expected, damaging earthquakes (eg, 2017 Mw 5.5 Pohang earthquake, South Korea).

Secondly, I want to show you how some mineral deposits form as a result of natural injection of high-pressure fluids that have escaped from very hot, deep crustal fluid reservoirs via active fault zones. I will illustrate natural hydrofracking using examples of "orogenic" type gold deposits that formed at depths of 10 -20 km and at temperatures of 250°C to 400°C in the Earth's crust. Some of these deposits formed as much as 2650 million years ago. Findings from engineered injection experiments are providing new insights about how quickly these gold deposits form, how long they take to form, and the volumes of fluids involved in ore formation.

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Day 2, September 7, 2021 (Tuesday)
Time: 16:30 - 18:00 JST

Guest Speaker

"Energy and Resources in the Global Picture and German Context"

Christoph HILGERS, Prof. Dr. rer. nat. habil.
Professor, Chair of Structural Geology and Tectonics
Karlsruhe Institute of Technology (KIT), Germany

BIO

Christoph Hilgers, Prof. Dr. rer. nat. habil. is full professor for Structural Geology and Tectonics and executive director of the Institute of Applied Geosciences at KIT. His interests are energy systems, raw-material efficiency, reservoir quality prediction, transnational higher education as well as process- and strategy analyses. After his studies of Geology at RWTH Aachen University and Applied Structural Geology & Rock Mechanics at Imperial College London, he worked as researcher at RWTH Aachen before moving to Quality Management & Metrology, Mechanical Engineering at WZL. Here he designed and planned GUtech as subsidiary of OES LLC, which he then set-up and managed in Muscat, Oman. He later became professor of Reservoir-Petrology at RWTH Aachen University before moving to KIT in 2016. He is a member of several professional and interdisciplinary boards such as the State's ThinkTank Industrial Resources Strategies, RawMaterialsKnowledge e.V., the national scientific association of the up- and downstream industry DGMK, among others. Link to his full profile is here.

ABSTRACT

The energy transition towards net-zero is pushed forward by many countries to reduce anthropogenic CO2 emissions. This is expected to become a global transition from fossil energies, currently covering about 80% of the world's energy, to renewable energies such as wind, solar and geothermal. Additionally, hydrogen generated from renewables and other sources may act as a storage of energy generated by fluctuating wind and solar, as well as being an important molecule for chemical and industrial processes. While several countries promote nuclear energy, this will be (among other energy types) phased out in Germany.

Growing world population and increasing global wealth will further increase energy and raw material demand, amplified by the energy transition. The supply of raw materials is challenged by the required volumes, the necessary higher rates of extraction and the costs of raw materials, considering both natural resources and recycling.

Since the energy plants for renewables require higher volumes of raw materials per generated MW, the demand and thus exploration and mining will significantly increase. Additionally, the interim storage of large renewable energy volumes such as hydrogen, heat and cold, as well as CO2 sequestration and geothermal energy lies subsurface. Thus, the energy transition is a geological and engineering challenge.

Although more and more elements become critical, the supply of raw materials is not limited by geological scarcity but faces several aspects summarized as STEEPLE-analysis. Besides geological aspects this covers S = socio-cultural, T = technological, E = economic, E = ethical, P = political, L = legal and E = environmental aspects.

For applied geology, such energy transition towards net-zero is thus a transition from exploration and production of the energy raw materials natural gas, oil and coal towards increased metal exploration required for renewable energy plants, subsurface storage and geothermal energy. Geology may also contribute to raw material quality assurance, recycling, and certification of supply chains including STEEPLE aspects.

Here, I present some aspects of the energy transition, addressing the approach taken in Germany and a geologist's global view.

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Day 3, September 8, 2021 (Wednesday)
Time: 10:30 - 12:00 JST

Guest Speaker

"Urban Mining towards Environmental and Resource Sustainability: Science, Technology, and Policy"

Xianlai ZENG, Ph.D.
Associate Professor, School of Environment
Tsinghua University, China

BIO

Xianlai Zeng, Ph.D. studied urban mining, metal sustainability, and circular economy as associate professor at Tsinghua University. He was Fulbright visiting fellow in Yale from 2018 to 2019. He ever worked as technical advisor of United Nations Development Programme (2015), visiting staff of Coventry University (2012), and visiting professor of Macquarie University (2017). Regarding urban mining, he established the method to measure the recyclability and recycling of e-waste, and developed many key pilot processes to recover metals. Regarding metal sustainability, he also established some methods to identify the sustainable utilization of metals (e.g., lithium, cobalt, nickel, lead, tin, and gallium). In waste recycling and circular economy areas, Prof. Zeng has published around 100 articles, patents, and books.

ABSTRACT

An increasingly multitude of underground mineral resources are being transferred into products and waste, which in turn can be an anthropogenic resource or urban mineral. Urban mining has been recognized as an important solution for environmental and resource sustainability. This talk will involve many disciplines covering environmental science and engineering, industrial ecology, green chemistry, sustainability science, and earth science. The urban mining story on what, why, how, and next direction from science and technology to policy and industry will be addressed in detail. The seminar presentation will take around one hour.

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Day 3, September 8, 2021 (Wednesday)
Time: 16:30 - 18:00 JST

Guest Speaker

"Systems Science Approach to Critical Metals Sourcing"

Saleem H. ALI, Ph.D.
Professor, Geography and Spatial Sciences
University of Delaware, USA

BIO

Saleem H. Ali, Ph.D. is the Blue and Gold Distinguished Professorship in Energy and the Environment at the University of Delaware, and is also a Senior Fellow at Columbia University's Center on Sustainable Investment. His research focuses on environmental security, climate diplomacy and industrial ecology, particularly involving extractive industries. Professor Ali's fieldwork experience has spanned over 100 countries on six continents for which he has also been named a National Geographic Explorer and a Young Global Leader by the World Economic Forum. His books include Treasures of the Earth: Need, Greed and a Sustainable Future, (Yale Univ. Press) and Environmental Diplomacy (with Lawrence Susskind, Oxford Univ. Press), as well as over 120 peer reviewed journal articles. Professor Ali received his doctorate in Environmental Planning from MIT, a Master's degree in Environmental Studies from Yale University, and Bachelor's degree in Chemistry from Tufts University (summa cum laude). He is a citizen of Australia, Pakistan and the United States. You may review his full bio here.

ABSTRACT

My talk will be on **Systems Science Approach to Critical Metals Sourcing.** This presentation will consider the importance of systems science approaches to environmental impact assessment with a comparison of minerals from terrestrial and oceanic sources. I would recommend the students read following articles:

- A model for "smart" mineral enterprise development for spurring investment in climate change mitigation technology
- Life cycle climate change impacts of producing battery metals from land ores versus deep-sea polymetallic nodules