Sustainable Waste Management
Content

Introduction and overview of APRU Sustainable Waste Management Program 3
Director 4
Co-Directors 4
APRU-SWM Core Group Members 5-7
Members of APRU Universities 8
Members of Non-APRU Universities 9-12
Important News and Articles of APRU SWM Program 13-16

Major Activities and Accomplishments in 2020
1. APRU SWM lab visits and training 17
2. APRU SWM online discussion session I (Skype meeting) 18
3. APRU SWM group meeting 18
4. APRU SWM online discussion session II (Zoom meeting) 19
5. APRU SWM online discussion session III (Zoom meeting) 19
6. APRU SWM solar cell and microplastic research 20
7. APRU SWM online discussion session IV (Skype meeting) 20
8. APRU SWM greenhouse experiments 21
9. APRU SWM online discussion session V (Zoom meeting) 21
10. APRU SWM experimental discussions 22
11. APRU SWM core group meeting 22
12. APRU SWM workshops and conferences 24
   Nature Forum on Plastics and Sustainability 24
   2nd Australian Circular Economy Conference 25
   2nd Engineering Sustainable Development Conference 26
13. Policy influence for the program’s future development 27
14. Planned activities in year 2021 27-33
15. Selected Publications 34-36
16. Appendix 37-49
Introduction and overview of APRU Sustainable Waste Management Program

Waste such as food waste, yard waste, agricultural waste, sewage sludge, industrial waste, and e-waste imposes critical burdens on the environment, consuming precious land resources, and aggravating global warming. Currently, waste management has become a major challenge for most countries throughout the world. Deposition of waste in residential areas, uncontrolled landfills, illegal dumping of waste to waterways, and marine environment results in severe land, water, and air pollution causing tremendous negative impacts not only for humans but also for floral and faunal diversity in ecosystems. Hence, the development of sustainable waste management strategies has become a major concern throughout the world. Thus, this program focuses on “recycling” and “recovery” of waste material while paving the way towards soil remediation, land remediation, and groundwater remediation with water and wastewater treatments.

This program will offer a timely opportunity for knowledge exchange among professionals all over the world to assist the formulation of an efficient sustainable management agenda for organic waste and remediation of soil, land, and groundwater in the local context, which satisfies the environmental compatibility, financial feasibility, and social needs. It will deliberate the state-of-the-art treatment technologies, advanced management strategies, and political issues pertaining to recycling and recovery of organic waste.

Moreover, local and overseas experts from different sectors including academic researchers, industrial practitioners, green groups, and government departments will be gathered in this program to solicit scientific and technical inputs as well as political feedback, facilitating the development of integrated solutions. Experienced industrial practitioners, professional organizations, green groups, as well as government officers are invited to the conference.

The program is hosted by the Korea University (Seoul, Korea) together with APRU and supported by APRU member universities as well as non-APRU universities including Stanford University in USA, Nanyang Technological University in Singapore, National University of Singapore in Singapore, University of Queensland in Australia, Chulalongkorn University in Thailand, Fudan University in China, Nanjing University in China, University of Technology Sydney in Australia, The University of Sydney in Australia, and National Taiwan University in Taiwan.
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Important News and Articles of APRU SWM Program

Date: 28th May 2020

APRU’s Sustainable Waste Management Program highlighted in Nature’s May issue

We are proud to note that Nature, the world’s leading multidisciplinary science journal, in its latest issue highlighted key experts from Korea University, including Korea University’s Global Research Director Yong Sik Ok for his role as the leader of the APRU Sustainable Waste Management Program. Read the full post on Nature, today.

The program, inaugurated at Korea University in December 2019, focuses on the technical challenges for the recycling and recovering of waste materials while paving the way towards a circular economy, land reclamation, and water and wastewater treatments. It will feed into the Nature Conference on Waste Management and Valorization for a Sustainable Future, to be hosted by Ok in Seoul in October 2021.

“Waste management on the land and the seas has become a major national, regional, and global challenge,” Nature quoted Ok as saying.

“We need to develop better strategies for more effectively managing our waste, which not only seek to reduce waste but also seek to derive value from the waste we generate through, for example, the conversion of waste to energy and value-added products such as biochar,” Ok added.

Nature went on to highlight Korea University’s success in creating the next generation of solar cells and helping the world transition to more efficient and cleaner renewable energy technologies. Research by Korea University’s Associate Professor in Architectural and Social Engineering Jun Hong Noh has been focused on developing solar cells made from perovskite, a mineral with a hybrid organic-inorganic structure. Perovskite solar cells are not only more efficient, lighter, cheaper, and easier to produce than conventional silicon-based cells, they can also be made into flexible devices.

Nature also featured Korea University’s research on atrial fibrillation; the pioneering work of Young-Hoon Kim, Vice President, Professor and Executive Director of the Cardiovascular Center at Korea University Anam Hospital, has led to improved diagnoses and treatments.

Nature furthermore highlighted Korea University’s prowess in developing state-of-the-art imaging techniques, such as coherent multidimensional spectroscopy, which has allowed scientists to capture real-time images of the high-speed chemical reactions that occur at the molecular level.

APRU Sustainable Waste Management Program leader Ok was the first Korean to be selected as a Highly Cited Researcher (HCR) in the field of Environment and Ecology by the Web of Science’s HCR index with 60 Highly Cited Papers and Hot Papers.

Korea University has been ranked the top private university in Asia — for the fourth consecutive year — on the Quacquarelli Symonds (QS) world rankings list.

(URL: https://www.nature.com/articles/d42473-020-00128-6)
COVID-19’s unsustainable waste management

The coronavirus disease 2019 (COVID-19) pandemic has led to an abrupt collapse of waste management chains. Safely managing medical and domestic waste is crucial to successfully containing the disease. Mismanagement can also lead to increased environmental pollution. All countries facing excess waste should evaluate their management systems to incorporate disaster preparedness and resilience.

Wuhan, the COVID-19 epicenter of China, experienced a massive increase of medical waste from between 40 and 50 tons/day before the outbreak to about 247 tons on 1 March. Cities such as Manila, Kuala Lumpur, Hanoi, and Bangkok experienced similar increases, producing 154 to 280 tons more medical waste per day than before the pandemic. Meanwhile, the widespread lockdown has caused a substantial increase in domestic waste in the United Kingdom. These large amounts of waste require collection and recycling, both of which are compromised as a result of manpower shortages and efforts to enforce infection control measures.

Disrupted services have led to waste mismanagement increases of 300% in some rural UK communities. With fewer options available, traditional waste management practices such as landfills and incineration are replacing more sustainable measures such as recycling, with adverse effects on the environment. The U.K. Environment Agency further threatens the environment by allowing temporary storage of waste and incineration ash at sites that have not been granted a permit, as is usually required.

To address the overflow of medical waste, the United Kingdom and other affected countries should install mobile treatment systems near hospitals and health care centers. The design and analysis of sustainable waste management chains, including logistics, recycling, and treatment technologies and policies, should be prioritized. To reduce the socioeconomic and environmental impacts of waste management, the whole system must be considered, including waste generation, collection, transport, recycling and treatment, recovered resource use, and disposal of remains. Protecting waste management chains will help achieve sustainable cities and communities as outlined in the UN Sustainable Development Goals.

(URL: [https://science.sciencemag.org/content/368/6498/1438.1](https://science.sciencemag.org/content/368/6498/1438.1))
Bacterial biofilms found on microplastics in aquatic ecosystems have been shown to include bacteria with antibiotic resistant genes. These resistant bacteria likely originate in human and animal populations treated with antibiotics and then travel downstream through wastewater into riverine and marine ecosystems. The increasing surface area provided by waste plastics, such as polyethylene, which may enable higher rates of biofilm growth, including those containing antibiotic-resistant genes. The possibility that plastic pollution can facilitate resistance to antibiotics has critical implications for the spread of disease and the management and regulation of antibiotic resistance in the environment. Although scientists have made important strides in understanding the direct effects of microplastics on animal and plant life, the indirect effects of plastic pollution, including the sources and transport dynamics of antibiotic resistance remain unclear. Scientists and policymakers should prioritize the evaluation of both direct and indirect effects of plastic pollution to fully assess the environmental and public health risks.

(URL: https://science.sciencemag.org/content/369/6509/1315/tab-pdf)
Date: 23rd June 2020

Metal contamination and bioremediation of agricultural soils for food safety and sustainability

Metal contamination and bioremediation of agricultural soils for food safety and sustainability

Agricultural soil is a non-renewable natural resource that requires careful stewardship in order to achieve the United Nations’ Sustainable Development Goals. However, industrial and agricultural activity is often detrimental to soil health and can distribute heavy metal(loid)s into the soil environment, with harmful effects on human and ecosystem health. In this Review, we examine processes that can lead to the contamination of agricultural land with heavy metal(loid)s, which range from mine tailings runoff entering local irrigation channels to the atmospheric deposition of incinerator and coal-fired power-plant emissions. We discuss the relationship between heavy metal(loid) biogeochemical transformations in the soil and their bioavailability.

We then review two biological solutions for remediation of contaminated agricultural land, plant-based remediation and microbial bioremediation, which offer cost-effective and sustainable alternatives to traditional physical or chemical remediation technologies. Finally, we discuss how integrating these innovative technologies with profitable and sustainable land use could lead to green and sustainable remediation strategies and conclude by identifying research challenges and future directions for the biological remediation of agricultural soils.

(URL: https://www.nature.com/articles/s43017-020-0061-y)
Major Activities and Accomplishments in 2020

1. APRU SWM lab visits and training

Date: 6th April, 2020

Activity: Visiting organic and inorganic solar cell production laboratory

The following topics were discussed:

- Organic solar cell labs can provide solar cells based on our need in terms of quantity and necessary fabrication.
- Simple structure of organic solar panels is ‘Glass/indium tin oxide (ITO)/Zinc oxide (ZnO)/ photoactive layer (polymer)/ MoO₃/Ag’
- The photoactive layer often fabricated with ZnO as electron acceptor
- Grinding (ball mill) of solar panel/cell and mixing with soil in order to get contaminated soil
- Measuring soil properties and conducting microcosm experiment after mixing of solar cell powder.
- Measuring metal uptake ability (bio-availability) of a plant grows in contaminated soil and toxic effect on plant physiology and morphology.
- Doing leaching tests and analyzing the micro-plastic and metal in leachates.
- Finally, determining the bio-char efficiency to decontaminate the contaminated soil.

Activities in inorganic solar cell production lab (Prof. Jun Hong Noh’s group)

The following topics were discussed during the lab visit:

Perovskites (CH₃NH₃PbI₃) contain both organic and inorganic compounds. Organic methylammonium cations surrounded by heavy metal atoms such as lead or tin and atoms like iodine in Perovskite solar cells.

- Inorganic solar cell labs will provide Perovskites cells prepared with diverse concentrations of lead and/or tin.
- Grinding of Perovskite cells and mixing with soil in order to get contaminated soil
- Measuring the soil properties and conducting microcosm experiment after certain time of mixing.
- Prof. Noh’s group recycled the PbI₃ (instead dumping of Perovskite) to reuse and submitted the work in a nature journal.
- Separation of metal (lead) in (Dimethyl sulfoxide) DMSO/Dimethylformamide (DMF) solvent for recycling purpose and observe the metal accumulation in soil using AAS, ICP, ICP-MASS and synchrotron technique.
2. APRU SWM online discussion session I (Skype meeting)

Date: 16th April 2020 (1:00 am to 12:10 pm)

Discussed topic in meeting

- The standard should be global (not Korean) concentration of metal in soil. Need to be careful about total concentrating and available concentrations when looking for guideline value of metal.
- We can add lead isotope in Perovskite Solar Cell (PSC). If we use lead isotope impregnated PSC then we can track the source of the Isotope. So, we can determine how exactly those Pb transfer from the soil to crop and so on.
- Soil microbiome experiment
- Data collection from China and Korean solar park
- Establishment of greenhouse and field experiments. There are few sites where solar panel was broken by typhoon and accident, so that contaminant release might be of interest.
- There are two conferences, one will be held in Shanghai together with nano technology,
- Second one is a nature conference next year and there is one important session: solar panel waste.
- Collecting data during review on solar panels can be used for life cycle analysis that may have use for generalized prediction rather than Empirical one.
- Solubilizing used solar cells in organic solvent and then recover Pb using a different type of adsorbent. Lead (in adsorbent such as Nano-scale hydroxyapatite) speciation and purity of PbI is important in the recycling aspect.

3. APRU SWM group meeting

Date: 17th April 2020 (10:00 am to 12:15 pm)

Attendee:
1. Md Niamul Haque
2. Pavani Dulanka Dissanayake
3. Yongmun Yeom

Discussed topic in meeting

- Setup the incubation and soil amendment experiment
- Measuring the initial compositions/parameters of soil
- Set up short- and long-term incubation
- Purchasing the necessary items for incubation experiment
• Detailed discussion with Kyungmun Yeom (PhD associate in Prof. Noh’s lab) on perovskite solar cell production method and constituents. They produce two type PSC structure with;
  
i. Au/Spiro-OMeTAD/CH₃NH₃PbI₃/Stannic oxide (SnO₂)/Fluorine-doped tin oxide (FTO)/glass’ and
  
ii. ‘Au/Spiro-OMeTAD / CH₃NH₃PbI₃/TiO₂/FTO’
• Kyungmun Yeom will give the layer details of PSC component used in their cell by making ppt
• PSC contain 600 nm of CH₃NH₃PbI₃ and tin (Sn) of 20 nm thickness in a single PSC cell
• Using acid digestion of PSC to know the metal concentration in PSC, because inorganic lab only knows the thickness of perovskite layer, Spiro-OMeTAD, and SnO₂, they cannot say actual concentration of lead in perovskite layer.
• Discussed recycling of PbI₂ from PSC, whether we can use biochar as absorbent to absorb PbI or not while previous research used hydroxyapatite.
• Apatite (Ca₁₀(PO₄)₆(OH)₂ also called HAP) shows a remarkable efficiency for the absorption of Pb²⁺ ions through ion exchange between Ca²⁺ and Pb²⁺ (Cui et al., 2015; Lei et al, 2015; Kim et al., 2016)

4. APRU SWM online discussion session II (Zoom meeting)

Date: 23rd April 2020 (8:00 pm to 9:00 pm)

Discussed topic in the meeting

The topics presented by Md. Niamul Haque are:
  • Recycling of solar cells
  • Bio-availability and toxic effect of contaminant in plant
  • Solar parks impact on ecosystem

The topic presented by Pavani Dulanja Dissanayake are:
  • Mobility and bioavailability of Pb and Sn in solar cell waste contaminated soil
  • Microcosm experiment

How can we conduct our experiment that will represent the real scenario?

Compare the data achieved form experiment and solar park

Prof. Rinklebe wanted to host Pavani at his lab in Germany for microcosm experiment

5. APRU SWM online discussion session III (Zoom meeting)

Date: 29th April 2020 (10:30 am to 12:00 pm)

Discussed topics in meeting are as following.
  • Pavani presented her research on the topic of ‘Mobility and bioavailability of Pb and Sn in solar cell waste contaminated soil’.
Prof. Ok provided proper guidelines including metal analyzing in soil, research equipment and materials collection, communication with expert scientists, and so on to start the research.

- Discussed to set up incubation experiment
- Discussed to set up bioavailability and metal uptake experiment in greenhouse
- Discussed purchasing materials needed for the greenhouse experiment

6. APRU SWM solar cell and microplastic research
**Date: 11th May 2020**

Cleaning the greenhouse for soil contaminated with solar cell and microplastic research

7. APRU SWM online discussion session IV (Skype meeting)
**Date: 20th May 2020**

**Activity: Skype meeting with National Taiwan University**
Meeting covered the following topics:
- Introducing among group members
- Prof. Ok, director of APRU SMW gave a talk on ‘APRU SWM Intro and activity’
- Katie Shin gave a presentation on ‘Application of Biochar on Hydrogen Evolution Reaction for Water’
- Po-Chang Wu gave a talk on ‘Sewage sludge biochar coated with MnO₂ as a pseudocapacitive composite electrode for energy storage and electrochemical water desalination’

National Taiwan University express the interest to start collaboration with APRU SMW on electrochemistry research area.
8. APRU SWM greenhouse experiments

Spread the experimental soil for drying in greenhouse 22nd May 2020

The soil collected from Busan has been dried in the greenhouse floor. The soil will be used in experiments. There are two types of soil, one is no contamination and another one is contaminated with microplastic.
Gathering the soil and make ready for keep in box and shelf, transferring biochar and fertilizer in plastic container, and ready greenhouse for setting up the experiment on 28th May 2020.

9. APRU SWM online discussion session V (Zoom meeting)

Date: 31st May 2020 (11:00 am to 12:30 pm)

Activity: Meeting with National University of Singapore

Meeting was included with the following issues:

- Kumuduni N Palansooriya and Li Jie talked on the topic of ‘Immobilization of Potentially Toxic Elements in Biochar Amended Soils: Review and Machine Learning Exploration’
- Manu Shivanand Suvarna presented his research under the title of ‘The application of machine learning methods for prediction of CO₂ adsorption on biochar’
- Pavani Dulanja Dissanayake talked on the topic with ‘Application of machine learning-methods for prediction of CO₂ adsorption on biochar’
- Prof. Xiaonan Wang talked on ‘Machine Learning Results and Missing data prediction’
10. APRU SWM experimental discussions

Date: 3rd June 2020

Prof. Ok’s visiting in greenhouse along with group member after KBRC bi-weekly meeting
Prof. Ok visited the greenhouse with group members and provided guidance about greenhouse management, research technique, equipment organization, importance of research, and so on.

11. APRU SWM core group meeting

Date: 25th September 2020 (12:00 pm to 1:00 pm)

Agenda

<table>
<thead>
<tr>
<th>Time (KST)</th>
<th>Activities</th>
</tr>
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<tbody>
<tr>
<td>12:00 PM - 12:05 PM</td>
<td>Welcome and introduction</td>
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<tr>
<td>12:05 PM - 12:10 PM</td>
<td>Welcome new core group members (The University of Sydney and National Taiwan University)</td>
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<tr>
<td>12:10 PM - 12:20 PM</td>
<td>Updates from the APRU Secretariat (Ms. Christina Schönleber)</td>
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<tr>
<td>12:20 PM - 12:40 PM</td>
<td>APRU activities: Discussion I 2nd Engineering Sustainable Development Conference</td>
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<tr>
<td>12:40 PM - 12:55 PM</td>
<td>APRU activities: Discussion II APRU SWM Virtual Winter School</td>
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<tr>
<td>12:55 PM - 1:00 PM</td>
<td>Discussion on 2021 Program Focus</td>
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</tbody>
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Participants in the meeting

Core group members
1. Prof. Yong Sik Ok, Korea University, Korea
2. Prof. William Mitch, Stanford University, USA
3. Prof. David Wardle, Nanyang Technological University, Singapore
4. Prof. Chi-Hwa Wang, National University of Singapore, Singapore
5. Prof. Sutha Khaodhir, Chulalongkorn University, Thailand
6. Prof. Xiaonan Wang, National University of Singapore, Singapore
7. Prof. Shicheng Zhang, Fudan University, China
8. Prof. Hwai Chyuan Ong, University of Technology Sydney, Australia
9. Prof. Cheng Gu, Nanjing University, China
10. Prof. Ali Abbas, The University of Sydney, Australia
11. Prof. Chia-Hung Hou, National Taiwan University, Taiwan
12. Ms. Christina Schönleber, APRU International Secretariat

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2. Prof. Hailong Wang, Foshan University, China
3. Prof. Hankwon Lim, Ulsan National Institute of Science and Technology, Korea
4. Dr. Binoy Sarkar, Lancaster University, UK
5. Prof. Xiaomin Dou, Beijing Forestry University, China
6. Prof. Ondřej Mašek, University of Edinburgh, Scotland
7. Prof. Zhengang Liu, Chinese Academy of Sciences, China
8. Prof. Nabeel Niazi, University of Agriculture Faisalabad, Pakistan
13. Ms. Tina Lin, APRU International Secretariat
14. Prof. Xiangzhou Yuan, Korea University, Korea
15. Ms. Kumuduni N Palansooriya, APRU SWM Secretariat, Korea University, Korea
16. Ms. Pavani Dissanayake, Korea University, Korea
17. Ms. Yoora Cho, Korea University, Korea
Plastic pollution is a pressing environmental and public health problem, related to the large quantities of single-use plastics, its persistence in the environment, and low rates of plastic recycling and regeneration. Plastic particles in the environment are projected to increase significantly in upcoming years, and products of their degradation — micro(nano)plastics (MNPs) — are transported through aquatic and terrestrial ecosystems.

During this Nature forum, plastic waste management, the fate, transport and effects of MNPs in the environment, and public policy will be discussed.

A panel discussion with the speakers will follow, to identify key research needs in plastic research and to provide potential solutions to plastic pollution in the context of the relevant United Nation’s Sustainable Development Goals (UN SDGs).

(URL: https://conferences.nature.com/event/29cec893-4116-4558-9582-f1843f322fa8/summary?environment=P2&5S%2CM3%2C29cec893-4116-4558-9582-f1843f322fa8=)
The 2nd Australian Circular Economy Conference (ACEC) has partnered with universities, government, and industry leaders in the Asia-Pacific region to deliberate on the progress, innovation, and benefits of a circular economy. We will be shining a spotlight on the industries and businesses actively using circular economy principles. You will be able to join us in person or virtually, wherever you are in the world.

The conference is co-hosted by the Waste Transformation Research Hub, the Sydney Knowledge Hub, APRU Sustainable Waste Management, and NSW Circular.

(URL: http://australiancircular.com/)
Date: 15-17th December 2020

2nd Engineering Sustainable Development Conference

Co-hosted by AIChE and APRU Sustainable Waste Management Program, the Engineering Sustainable Development 2020 brought engineers, scientists, and policymakers together to discuss technical and engineering challenges of addressing the 2030 Agenda for Sustainable Development and the 17 Sustainable Development Goals (SDGs).

Topics of this year’s conference include:
Plastic waste/microplastics
Electronic waste: waste batteries, waste solar panels
Biowaste in the circular economy
Soil, water and air pollution
Biodiversity in ecosystems
Policy development toward sustainable waste management

(Url: https://www.aiche.org/ifs/conferences/technical-and-engineering-challenges-addressing-sustainable-development/2020)

Best student presentations

1. Antonella Cornelio, University of Brescia
   Topic: New Porous Materials Derived from Industrial By-Products for Nanoparticles Capture

2. Sherif A. Khalifa, Drexel University
   Topic: Environmental Impacts of Upscaled Mixed Cation Perovskite Precursors for Emerging Lead Halide Perovskite Solar Cells

3. Jessica MacDonald, Stanford University
   Topic: Linking Anaerobic Wastewater Treatment to Non-Potable and Potable Wastewater Reuse

4. Kumuduni Niroshika Palansooriya, Korea University
   Topic: Machine Learning-Based Prediction of Immobilization Efficiency of Potentially Toxic Elements in Biochar Amended Soils

Best poster presentation

1. Tsz Yan Yu, The University of Queensland
   Topic: Circular Economy Regulations on Waste Management and the Implementation in Australian Cities
13. **Policy influence for the program’s future development**

APRU SWM program has been organizing various conferences and workshops to provide excellent opportunity for participants to share their work with fellow scientists, policy makers and industrial personnel. APRU SWM members will collaborate with scientists, industrial personnel and policy makers and they will review existing international policies, agreements and frameworks addressing waste management and soil and ground water remediation and assess their effectiveness and propose ways to improve them. In addition, novel research findings of the project on “Effect of plastic mulch wastes on soil quality and crop productivity in agro-environments” will be handed over to the government to enhance their concern on environmental protection and relevant policy making. Collaboration with external partners and policy makers will be enhanced through this conferences and workshops in order to actively feed into ongoing policy discourse in the region. The aim over the next few years will be to increase and advance program’s policy impact.

14. **Planned activities in year 2021**

- **APRU SWM Global Lecture Series**

**Speakers**

**March 2021**

![Prof. Jessika Trancik](https://trancik.mit.edu/)

**Prof. Jessika Trancik**
Massachusetts Institute of Technology, USA
Email address: trancik@mit.edu
Website: [http://trancik.mit.edu/](http://trancik.mit.edu/)

**April 2021**

![Prof. Ah-Hyung (Alissa) Park](https://www.cheme.columbia.edu/faculty/ah-hyung-alissa-park)

**Prof. Ah-Hyung (Alissa) Park**
Director, Lenfest Center for Sustainable Energy
Chair, Department of Earth and Environmental Engineering
Columbia University in the City of New York, USA
Email address: ap2622@columbia.edu
Website: [https://www.cheme.columbia.edu/faculty/ah-hyung-alissa-park](https://www.cheme.columbia.edu/faculty/ah-hyung-alissa-park)
May 2021

Prof. David Wardle
Full Professor and Smithsonian Chair
Nanyang Technological University, Singapore
Email address: david.wardle@ntu.edu.sg
Website: https://dr.ntu.edu.sg/cris/rp/rp00090

May 2021

Dr. Carlos Antonio Guerra
Co-leader, Global Soil Biodiversity Observation Network
German Center for Integrative Biodiversity Research (iDiv), Germany
Institute of Biology/Geobotany and Botanical Garden, Martin Luther University Halle-Wittenberg, Germany
Email address: carlos.guerra@idiv.de
Website: https://geobon.org/bons/thematic-bon/soil-bon/

June 2021

Prof. Johannes Lehmann
Cornell Atkinson Center for Sustainability, USA
School of Integrative Plant Science, Cornell University, USA
Institute for Advanced Study, Technical University of Munich, Germany
Email address: CL273@cornell.edu
Website: https://cals.cornell.edu/johannes-lehmann

July 2021

Prof. Jinyue Yan
Royal Institute of Technology (KTH), Sweden
Editor-in-Chief of Applied Energy
Email address: jinyue.yan@mdh.se
Website: https://www.kth.se/profile/jinyue
**APRU SWM Virtual Winter School**

January 12th (Tuesday, KST) / 11th (Monday, California time)

Session: Wastewater Treatment and Recycling

<table>
<thead>
<tr>
<th>Time</th>
<th>APRU SWM Plenary Speakers (Chair: Prof. Yong Sik Ok, Korea University, Korea)</th>
<th>APRU SWM Student Presentations (Chair: Prof. William Mitch, Stanford University, USA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4:00 PM ~ 4:50 PM (California time)</td>
<td>Prof. William Mitch Stanford University, USA</td>
<td>RO and FO/RO for Centralized and Decentralized Potable Reuse Applications</td>
</tr>
<tr>
<td>4:50 PM ~ 5:05 PM</td>
<td>Jessica MacDonald Stanford University, USA</td>
<td>Linking Mainstream Anaerobic Secondary Treatment to Wastewater Reuse Trains</td>
</tr>
<tr>
<td>5:05 PM ~ 5:20 PM</td>
<td>Kumuduni Niroshika Plansooriya Korea University, Korea</td>
<td>Occurrence of Contaminants in Drinking Water Sources and the Potential of Biochar for Water Quality Improvement</td>
</tr>
<tr>
<td>5:20 PM ~ 5:35 PM</td>
<td>Jack King Stanford University, USA</td>
<td>GAC-Based Cathodes for The Capture and Degradation of Halogenated Contaminants in RO Concentrate or Stormwater</td>
</tr>
<tr>
<td>5:40 PM ~ 6:00 PM</td>
<td><strong>Live Q &amp; A and Panel Discussion</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Session Chair: Prof. Yong Sik Ok, Korea University, Korea</td>
<td>Panelist: Prof. Chia-Hung Hou, National Taiwan University, Taiwan Prof. Ali Abbas, The University of Sydney, Australia</td>
</tr>
<tr>
<td></td>
<td>Prof. William Mitch, Stanford University, USA</td>
<td></td>
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</tbody>
</table>

This session is available on APRU YouTube channel: [https://youtu.be/ TwgzRzr1xQ](https://youtu.be/ TwgzRzr1xQ)
**January 26th (Tuesday) (KST)**

**Session: APRU SWM’s 2nd Forum on Plastics and Sustainability**

<table>
<thead>
<tr>
<th>Time</th>
<th>Presenter</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:00 PM ~ 2:20 PM</td>
<td>Prof. Cheng Gu</td>
<td>Aging of Microplastics and the Effects on the Environmental Behaviors of Contaminants in Aquatic Environments</td>
</tr>
<tr>
<td></td>
<td>Nanjing University, China</td>
<td></td>
</tr>
<tr>
<td>2:20 PM ~ 2:40 PM</td>
<td>Prof. Defu He</td>
<td>Microplastics in Terrestrial Environments</td>
</tr>
<tr>
<td></td>
<td>East China Normal University, China</td>
<td></td>
</tr>
<tr>
<td>2:40 PM ~ 3:00 PM</td>
<td>Prof. Sutha Khaodhir</td>
<td>Materials Flow Analysis to Promote Circular Economy Development: A Case Study on Post-Industrial Plastic Waste in Thailand</td>
</tr>
<tr>
<td></td>
<td>Chulalongkorn University, Thailand</td>
<td></td>
</tr>
<tr>
<td>APRU SWM Student Presentations (Chair: Prof. Cheng Gu, Nanjing University, China)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:00 PM ~ 3:15 PM</td>
<td>Yoora Cho</td>
<td>Microplastics as Emerging Contaminants in the Environment</td>
</tr>
<tr>
<td></td>
<td>Korea University, Korea</td>
<td></td>
</tr>
<tr>
<td>3:15 PM ~ 3:30 PM</td>
<td>Chao Wang</td>
<td>Enhanced Alteration of Poly(vinyl chloride) Microplastics by Hydrated Electrons Derived from Indole-3-acetic acid Assisted by a Common Cationic Surfactant</td>
</tr>
<tr>
<td></td>
<td>Nanjing University, China</td>
<td></td>
</tr>
<tr>
<td>3:30 PM ~ 3:45 PM</td>
<td>Virin Kittithammavong,</td>
<td>Overview of Municipal Waste Characterization and Analysis in Thailand</td>
</tr>
<tr>
<td></td>
<td>Chulalongkorn University, Thailand</td>
<td></td>
</tr>
<tr>
<td>3:45 PM ~ 4:00 PM</td>
<td><strong>Live Q &amp; A and Panel Discussion</strong></td>
<td></td>
</tr>
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<td></td>
<td>Session Chair:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prof. Yong Sik Ok, Korea University, Korea</td>
<td></td>
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<td></td>
<td>Panelists:</td>
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<td></td>
<td>Prof. Cheng Gu, Nanjing University, China</td>
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<td></td>
<td>Prof. Defu He, East China Normal University, China</td>
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<tr>
<td></td>
<td>Prof. Sutha Khaodhir, Chulalongkorn University, Thailand</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prof. Xiaonan Wang, National University of Singapore, Singapore</td>
<td></td>
</tr>
</tbody>
</table>

This session is available on APRU YouTube channel: [https://www.youtube.com/watch?v=nBOIS6n7MhI&feature=youtu.be](https://www.youtube.com/watch?v=nBOIS6n7MhI&feature=youtu.be)
February 23rd (Tuesday) (KST)
Session: Biochar for Sustainable Development

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker Name</th>
<th>University/Institution</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:00 PM ~ 2:20 PM</td>
<td>Prof. Xiaonan Wang</td>
<td>National University of Singapore, Singapore</td>
<td>AI And Machine Learning Methods in Sustainable Environment and Waste Management</td>
</tr>
<tr>
<td>2:20 PM ~ 2:40 PM</td>
<td>Prof. Hwai Chyuan Ong</td>
<td>University of Technology Sydney, Australia</td>
<td>Bioformulation of Biochar as a Potential Inoculant Carrier for Sustainable Agriculture</td>
</tr>
</tbody>
</table>

APRU SWM Student Presentations (Chair: Prof. Xiaonan Wang, National University of Singapore, Singapore)

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker Name</th>
<th>University/Institution</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:40 PM ~ 2:55 PM</td>
<td>Shuang Song</td>
<td>E2S2-CREATE program, National University of Singapore, Singapore</td>
<td>Biochar for Urban Agriculture: Impacts on Soil Chemical Characteristics and on Vegetable Growth, Nutrient Content and Metabolism Over Multiple Growth Cycles</td>
</tr>
<tr>
<td>2:55 PM ~ 3:10 PM</td>
<td>Manu Suvarna</td>
<td>National University of Singapore, Singapore</td>
<td>Machine Learning Framework for Biochar Design with Pre-Determined CO₂ Adsorption</td>
</tr>
<tr>
<td>3:10 PM ~ 3:25 PM</td>
<td>Li Lanyu</td>
<td>National University of Singapore, Singapore</td>
<td>Optimal Design of Negative Emission Hybrid Renewable Energy Systems with Biochar Production</td>
</tr>
<tr>
<td>3:25 PM ~ 4:00 PM</td>
<td>Live Q &amp; A and Panel Discussion</td>
<td></td>
<td>Session Chair:&lt;br&gt;Prof. Yong Sik Ok, Korea University, Korea&lt;br&gt;Prof. Xiaonan Wang, National University of Singapore, Singapore&lt;br&gt;Panelists:&lt;br&gt;Prof. Hwai Chyuan Ong, University of Technology Sydney, Australia</td>
</tr>
</tbody>
</table>

This session is available on APRU YouTube channel: [https://www.youtube.com/watch?v=BIrjxWk5u-0](https://www.youtube.com/watch?v=BIrjxWk5u-0)
3rd Sustainable Waste Management Conference

Date: August 4-6, 2021

This conference will offer a timely opportunity for knowledge exchange among professionals all over the world to support the formulation of an efficient sustainable waste management agenda.

This year’s conference encompasses a diverse range of topics including:

- Waste to Energy
- Circular Economy
- Food Waste
- System Modeling
- Low Carbon Technology
- Biochar
- Plastics and Sustainability
- Wastewater Treatment and Recycling

The development of sustainable waste management strategies has become a major concern throughout the world. Thus, this program focuses on “recycling” and “recovery” of waste material while paving the way towards circular economy, land reclamation, and water and wastewater treatments. This program will offer a timely opportunity for knowledge exchange among professionals from all over the world to assist the formulation of an efficient sustainable management agenda for biological waste and remediation of soil, water and air in the local context, which satisfies the environmental compatibility, financial feasibility and social needs. It will deliberate on state-of-the-art treatment technologies, advanced management strategies, and political issues pertaining to recycling and recovery of organic waste. Moreover, local and overseas experts from different sectors including academic researchers, industrial practitioners, green groups, and government departments will be gathered in this program to solicit scientific and technical inputs as well as political feedback, facilitating the development of integrated solutions. Experienced industrial practitioners, professional organizations, green groups, as well as government officers are invited to the conference.

This conference aims to provide a forum to present research in regards to:
- Sustainable Waste Management
- Micro(nano)plastics in the Environments
- Electronic Waste and Circular Economy
- Reducing, Recycling and Recovery of Agricultural and Food Waste
- Biomass Valorization: Waste to Resources
- Governmental Policy on Waste Management and Valorization

Website: https://conferences.nature.com/WasteManagement
15. Selected Publications

Year 2020


**APRU SWM Secretary**

Kumuduni Niroshika Plansooriya

Korea Biochar Research Centre, APRU Sustainable Waste Management & Division of Environmental Science and Ecological Engineering, Korea University, Seoul 02841, South Korea
Appendix

Association of Pacific Rim Universities
Program Report 2020/2021

Sustainable Waste Management
Major Activities and Accomplishments in 2020

1. APRU SWM lab visits and training

Date: April 6th, 2020

Activity: Visiting organic and inorganic solar cell laboratory

Participants:
1. Prof. Yong Sik Ok
2. Prof. Jae Won Shim
3. Md Niamul Haque
4. Pavani Dulanja Dissanayake
5. Soobin Kim
6. Yoora Cho
7. Kyungmun Yeom (Student of Prof. Jun Hong Noh's lab)
8. Sunghyeon Kim (Student of Prof. Jae Won Shim’s lab)

Prof. Ok is instructing the objectives of our project to the student of organic solar lab including Prof. Jae Won Shim
Prof. Jae Won Shim and his PhD student are showing the lab activities to us, and we took a group photo at end of the lab visit.
Scientific discussion with among Prof. Ok, Kyungmun Yeom, and our lab members

Student of inorganic solar cell lab is responding our queries and describing the lab activities

Group photo at the end of inorganic solar cell lab visit
2. APRU SWM online discussion session I (Skype meeting)

**Date:** 16th April 2020 (1:00 am to 12:10 pm)

**Attendee:**

1. Prof. Yong Sik Ok
2. Prof. Daniel Alessi
3. Prof. Meththika Vithanage
4. Prof. Xiaonan Wang
5. Md. Niamul Haque
6. Pavani Dulanja Dissanayake
7. Ahmed Ashik
8. Katie Shin
9. Kyungmun Yeom

4. APRU SWM online discussion session II (Zoom meeting)

**Date:** 23rd April 2020 (8:00 pm to 9:00 pm)

**Attendee:**

1. Prof. Yong Sik Ok
2. Prof. Jörg Rinklebe
3. Prof. Meththika Vithanage
4. Prof. Binoy Sarkar
5. Md. Niamul Haque, PhD
6. Pavani Dulanja Dissanayake
7. Ahmed Ashik
8. Katie Shin
Some photo taken as closer look of greenhouse to show in meeting

5. APRU SWM online discussion session III (Zoom meeting)

Date: 29th April 2020 (10:30 am to 12:00 pm)

Attendee:

1. Prof. Yong Sik Ok
2. Dr. Avanthi Igalavithana
3. Md Niamul Haque
4. Pavani Dulanja Dissanayake
5. Katie Shin
6. Kumuduni N Palansooriya
7. Soobin Kim
8. Yoora Cho
7. APRU SWM online discussion session IV (Skype meeting)

Date: 20th May 2020

Activity: Skype meeting with National Taiwan University

Attendee:

1. Prof. Yong Sik Ok
2. Prof. Chia-Hung Hou
3. Nei-Ling Liu
4. Po-Chang Wu
5. Md Niamul Haque
6. Pavani Dulanja Dissanayake
7. Katie Shin
8. Kumuduni N Palansooriya
9. Soobin Kim
10. Yoora Cho

9. APRU SWM online discussion session V (Zoom meeting)

Date: 31st May 2020 (11:00 am to 12:30 pm)

Activity: Meeting with National University of Singapore

Participants:

1. Prof. Yong Sik Ok
2. Prof. Xiaonan Wang
3. Md Niamul Haque
4. Kumuduni N Palansooriya
5. Li Lanyu
6. Jie Li
7. Pavani Dulanja Dissanayake
8. Manu Shivanand Suvarna
9. Katie Shin
10. Soobin Kim
11. Yoora Cho
12. Ashiq Ahmed
11. APRU SWM core group meeting
Date: 25th September 2020 (12:00 pm to 1:00 pm)

- Welcome new core group members
  a. Prof. Ali Abbas, The University of Sydney, Australia
b. Prof. Chia-Hung Hou, National Taiwan University, Taiwan

Updates from the APRU Secretariat
Ms. Christina Schönleber

APRU activities: Discussion I

2nd Engineering Sustainable Development Conference

Main topics
Plastic production, usage, pollution and sustainable development
Wastewater treatment and recycling
Biochar for sustainable development
Discussion

Prof. Ok explained all the information on topics, speakers, and the aim of the ESD2020 conference. Then, gave feedback and suggestions for speakers that were requested from the audience.

Prof. Ali Abbas suggested that it would be great to add speakers on plastic production/remanufacturing so that it will fully cover the circulation of plastics. Prof. Ok agreed with the suggestion and will add more speakers related to the plastic production aspect. Prof. Ok also suggested Prof. Ali as a speaker for the plastic sessions.

Prof. William Mitch suggested finding more speakers who are dealing with plastics and wastewater or biochar and wastewater to have a kind of bridge between the sessions.

Prof. Ok agreed with the idea and decided to add a bridge session on the 2nd or 3rd day of the conference.

Prof. Mitch raised a question: “Christina’s slides showing all the different APRU universities, some of them are not necessarily represented. Should we try to round up some candidates from some of the ones who are represented here to see if there is relevant research going on at those universities?”

Ms. Christina suggested that the participants can cooperate for papers and research activities to raise the visibility of the program to the members who are not engaged in it.
Ms. Christina also suggested bringing more speakers from industry and policy sides related to the topics.

More importantly, based on the experience, Prof. Ok strongly recommended that our APRU should pay more attention to gender balance.

- **APRU activities: Discussion II**

**APRU SWM Virtual Winter School**

The APRU SWM Virtual Winter School is organized by the APRU SWM Program

- The event aims to share the research outcomes, experience, and discuss how to cope with the challenges faced by research students
- Students and post-doctoral researchers from APRU member universities are encouraged to join
- The event consists of two main sessions, real-time presentations and laboratory training program via a zoom platform

**Titles:**

- Particulate Plastic in Terrestrial and Aquatic Environments
- Wastewater Treatment and Recycling
- Biochar for sustainable development
**Discussion**

Prof. Ok explained all the information on topics, arrangements, speakers, and the aim of the APRU SWM Virtual Winter School. In addition, Yoora Cho, a PhD candidate at Korea University, explained how to conduct laboratory courses virtually.

Yoora mentioned that Korea University uses a platform called “Blackboard” to share the laboratory experiments with students. Pre-recorded videos can be uploaded on the system and students can watch the videos and send their reports via Blackboard. Thus, students and professors can actively communicate to share the information by utilizing this platform.

Then, feedback and suggestions for speakers were requested from the audiences. Ms. Christina suggested that it is good if we can provide certificates at the end of Virtual Winter School for the students who are attending the event.

Prof. Ok proposed a plan for the event with four main sessions:

a) The prerecorded laboratory experiment videos can be uploaded in the system and students can watch the before attending the event
b) Lectures by experts in the given topics area
c) Student presentations
d) Discussion session

Prof. Xiaonan Wang from National University of Singapore, Prof. Cheng Gu from Nanjing University, Prof. Ali Abbas from The University of Sydney, and Prof. Nabeel Niazi from University of Agriculture Faisalabad agreed to give their fullest support for the event.

Prof. Cheng Gu mentioned that they can provide laboratory demonstrations for plastic analysis for the event. Prof. Ok agreed with the suggestion and mentioned that Prof. Ok will provide the demonstration for plastic separation and pretreatment processes.

- **Discussion on 2021 Program Focus**

Prof. Ok explained the 2021 program focus, that is mainly about Nature conference.

Nature conference will be held from 26th to 28th October 2021 in Seoul, Korea. The title of the conference is “Waste management and Valorization for Sustainable Future”.

Six main sessions are available.

Session I: Sustainable Waste Management
Session II: Micro(nano)plastics in the Environments
Session III: Electronic Waste and Circular Economy
Session IV: Reducing, Recycling and Recovery of Agricultural and Food Waste
Session V: Biomass Valorization: Waste to Resources
Session VI: Governmental Policy on Waste Management and Valorization