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of Western Australia

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Pollution in Western Australia

One-day symposium-11 June 2022

Hill Lecture Theatre - Murdoch University

Program

Session I

9.00-9.05 AM Housekeeping & Social Media websites (Edda Guareschi, MD)

9.05-9.15 Welcome (Prof. Hans Lambers, RSWA President)

9.15-9.50 Keynote talk. Mobility of contaminants in global supply chains: how the AgriFood industry can limit industry damage in outbreak events. Cameron Scadding, Managing Director, Source Certain Intl. Ltd. (WA)

9.50-10.30 Seagrass in Cockburn Sound, Loss and Restoration: A Case Study of Marine Pollution in WA. Dr. Marion Cambridge (UWA) & A/Prof. Jennifer Verduin (MU)

10.30-10.55 Heavy metals in foraminiferal skeletons. Dr. Netramani Sagar (UWA)

10.55-11.25 **Morning Tea** ☕

Session II

11.25-11.50 The tragedy of the rivers: freshwater pollution in Western Australia. Prof. Alan Lymbery (MU)

11.50 AM-12.15 PM Assessing and managing the fate of reclaimed wastewater in Perth's deep aquifers. Dr. Henning Prommer (CSIRO)

12.15-12.40 Pollution implications from fire impacted, organic rich wetlands on the Swan coastal plain, southwestern Australia. Dr. David Blake (ECU)

12.40-1.40 **Lunch** 🍽️

Session III

1.40-2.05 PFAS: Beyond Defence – A burning issue. Prof. Nanthi Bolan (UWA)

2.05-2.30 Livestock production and its impact on climate change. Mandy Curnow (DPIRD)

2.30-2.55 Air pollution, climate change and birth outcomes in Western Australia: epidemiological evidence, challenges, and prospects. Sylvester Nyadanu (CU)

2.55-3.20 **Afternoon Tea** ☕

Session IV

3.20-3.45 Plastics in the South Coast of Western Australia. Dr. Harriet Paterson (UWA)

3.45-4.10 Plastic pollution on land. Dr. Andrew Rate (UWA)

4.10-4.35 Micro- & nano-plastics in the animal kingdom. A status of the knowledge and the presentation of a research project. Edda Guareschi, MD (MU)

4.35-5.00 **Closing Remarks**

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Abstracts

Pollution implications from fire impacted, organic rich wetlands on the swan coastal plain, southwestern Australia.

Dave Blake & Pierre Horwitz

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This presentation focuses on the pollution generated from fires, and fire management practices in organic rich wetlands on the Swan Coastal Plain, southwestern Australia and presents the findings of studies investigating air quality, pore- and groundwater responses and the implications of management practices in organic rich wetlands north of Joondalup.

Over the last decade the incidence of smouldering combustion events in organic-rich wetland sediments on the Swan Coastal Plain of southwestern Australia have increased in frequency and/or intensity and duration. These 'peat' fires can burn for extended periods, generating smoke, resulting in localised air quality impacts. The intimate link between wetland sediments and groundwater means that the combustion of wetland sediments has the capacity to influence water quality.

This presentation presents the findings of studies conducted over the last 15 years. The findings show that air quality impacts include episodic generation of high levels of PM10 and PM2.5 and the generation of volatile organic compounds, including both possible and probable

carcinogens. In groundwater, fire brought about a substantial increase in oxidation of sulfidic wetland sediments that resulted in the generation of acidic porewaters and the concomitant mobilisation of metal species. The generated acidity was found to be episodic in nature, varying with seasonal fluctuations of groundwater and fire management practices. In the long-term, the magnitude and repeated incidence of such events and their management, could lead to the erosion of the acid buffering capacity of these wetlands.

PFAS Beyond Defence

Nanthi Bolan

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Poly- and perfluoroalkyl substances (PFASs) are a diverse group of synthetic fluorinated compounds, which are bio-accumulative and toxic to humans and the environment. Aqueous film forming foam (AFFF) used in firefighting is a point source of PFAS input to soil and groundwater. Recently, there have been major concerns about contamination of groundwater sources with PFAS compounds in sites that have been testing AFFF for firefighting. Incidences of PFAS contamination of soil and groundwater sources have been noticed beyond defence sites that include landfills and wastewater treatment plants. Biosolids and landfills are two other major diffuse sources of PFAS input to soil and groundwater sources. This presentation provides an overview on the sources, distribution, toxicity, and remediation of PFAS compounds - beyond defence sites.

Seagrass in Cockburn Sound, Loss and Restoration: A Case Study of Marine Pollution in WA

Cambridge, ML¹ & Verduin, J²

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This combined talk gives a historical overview of the industrial development and seagrass loss from marine pollution and then considers the steps being undertaken in large scale restoration of this threatened ecosystem. Cockburn Sound (CS) was the first case of marine pollution in WA that was closely studied in the 1970's. Industries discharged waste waters along the Kwinana foreshore resulting in more than 75% of the seagrass lost over a few years (4000 ha to 900 ha). In the following decades, the seagrasses did not recover in most areas despite large reductions in pollutants. There is now a new resurgence of interest in CS seagrass because of the current plans for a new port. How feasible is large scale rehabilitation of seagrass meadows, opening the way to more wide-scale restoration of this threatened ecosystem?

Three hectares of seagrass were planted as an offset for seagrass loss in the Cockburn Sound region and subsequently monitored over a period of five years (2004-2012). Two local meadow-forming species of *Posidonia* were used and after seven years shoot densities had increased to 500 shoots per m², resembling nearby natural meadows. Innovation in the development of practical technical solutions for the rehabilitation of seagrasses was then taken a step further with the use of seeding in Owen Anchorage and Cockburn Sound.

Livestock production and its impact on climate change

Livestock production and its impact on climate change.

Mandy Curnow

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Livestock, in particular ruminants, have been labelled as a significant contributor to Greenhouse Gas emissions and hence climate change. WA has a significant livestock sector, mostly grazing on rangelands and improved pastures producing significant export income for the state and a supply of high quality meat and wool. In WA emissions from agriculture make up about 10% and livestock production ~6% of that. Livestock emissions are mainly driven by methane production which is a powerful warming gas and pundits are quick to point out that by eating less red meat we can save the planet. Exploring the emissions in WA and the opportunities for agriculture to contribute to the sequestration of carbon shows that we can have our beef and eat it too.

Micro- & nano-plastics in the animal kingdom. A status of the knowledge and the presentation of a research project.

Edda Guareschi

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Plastics are the synthetic organic polymers of monomers extracted from oil or gas. Mass production began in the 1940s and about 9 billion tonnes are estimated to have been produced until today, with hardly 10% being recycled. The scientific literature has covered the properties, nomenclature, sources and dimensions (macro-, micro- < 5 mm, nano- < 0.1 µm) of plastics in the environment, and scholarly articles about their impact on the global health, human and non-human, are increasing.

Focusing on samples of fish, invertebrates and mammalian tissues in Western Australia, the aim of the proposed research study is to determine the presence and the abundance of micro/nanoplastics in their organisms, and to review their potential impact on the global health of the WA community. The tissues samples will be provided by the Vet School and through activities of the Harry Butler Institute, both at MU. The assessment of plastics in tissues requires analytical techniques (e.g., FTIR), which will be performed and interpreted at Source Certain Intl. Ltd. (WA). The expected results are represented by the positive detection of micro/nanoplastics in the sampled tissues. Accumulation will be assessed and quantified. The discussion will focus on the health hazards posed by the presence of micro- and nano-plastics in living tissues and organs in WA, possible interventions/prevention, public awareness.

The tragedy of the rivers: freshwater pollution in Western Australia

Alan Lymbery

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Freshwater environments support much greater biodiversity than either the land or the sea, but this diversity is being lost at an alarming rate, with global populations of freshwater species having declined by an average of 83% in the last 50 years. Despite this, freshwater ecosystems receive very little political, public or even scientific interest, in comparison to terrestrial and marine ecosystems. In Western Australia, 80% of river systems have had major disturbances

to their hydrology and ecology, and 70% of wetlands on the Swan coastal plain have been lost since European settlement. The terrestrial reserve system is ineffective in preventing the loss of freshwater diversity. In addition, although the integrity of waterways is ostensibly protected by many separate pieces of legislation, a lack of integration and prioritisation of human use over ecosystem health values often means that protection is sub-standard. The conservation of Western Australia's unique freshwater biodiversity requires a major change in political and public mindset.

Air pollution, climate change and birth outcomes in Western Australia: epidemiological evidence, challenges, and prospects.

Sylvester D. Nyadanu, Gizachew A. Tessema, Ben Mullins, Gavin Pereira

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Objectives: To conduct the first umbrella review of systematic reviews and meta-analyses (SRMAs) on the associations between ambient air pollution or temperature and birth outcomes and the first primary study on climate change and birth outcomes in Western Australia (WA).

Methods: We systematically searched and synthesised SRMAs on ambient air pollution or temperature and birth outcomes (preterm birth, stillbirth, birth weight, low birth weight, and small-for-gestational age) from eight databases and three grey literature sources. We conducted a space-time-stratified case-crossover analysis of 2,835 singleton stillbirths and 15,576 singleton live births with spontaneous preterm birth (sPTB) and maternal exposures to daily Universal Thermal Climate Index (UTCI) between 1st January 2000 and 31st December 2015 in WA.

Results: For air pollution, 36 SRMAs (15 without and 21 with meta-analyses) were synthesised that contained 295 primary studies, predominantly from USA and China. Australia contributed 11 studies which included 3 from WA. Particulate matter pollutants (PM_{2.5}/PM₁₀) showed more consistent positive associations with birth outcomes than gaseous pollutants. There were 9 SRMAs on ambient temperature (8 without and 1 with meta-analysis) that comprised 78 primary studies. Australia contributed 7 primary studies but none of these was in WA. All 9 SRMAs concluded that extreme temperatures contributed to higher risks of birth outcomes. Primary analysis in WA showed that relative to no thermal stress (median UTCI), exposure to cold (1st percentile) and heat (99th percentile) stresses in the past six days up to the delivery day were associated with 14% (RR = 1.14, 95% CI: 1.12, 1.15) and 19% (RR = 1.19, 95% CI: 1.17, 1.21) greater risks of stillbirth, no association (RR= 0.99, 95% CI: 0.98, 0.99) and 5% greater risk (RR=1.05, 95% CI: 1.04, 1.06) of sPTB, respectively with substantial sociodemographic vulnerabilities.

Discussion: Both air pollution and extreme climates elevated the risk of birth outcomes, suggesting public health and climate change policies.

Plastics in the South Coast of Western Australia

Harriet Paterson

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Harriet Paterson is an independent researcher who has an interest in detecting and monitoring plastic in the marine and aquatic environments. She has concentrated her work on the South Coast of Western Australia, looking at the abundance of plastic on beaches and in biota. She concentrates on documenting the annual plastic load on Muttonbird Beach. Her students have

investigated the distribution of plastics on large bays and drivers of daily abundances on Shelly Beach with help from WOW Eco Cruises. Her work has also explored the plastic abundance on Penguin Island, where an unusually high load of plastic can be found. One of the more novel investigations has been quantifying the plastic load in Beak Salmon, whose larvae accumulate at the shelf edge. These fish were collected in boluses regurgitated by Brown Noddies during annual surveying on Lancelin Island. She is responsible for developing the TransPlas Network which has linked academics from the UK and China, resulting in collaborations between academics, students and has produced an international paper. This program included Western Australian students examining the plastic loads in seagrass beds of the Swan River and in estuaries of the southwest, in the water column and bivalves. Dr Paterson has been recognised for her work and was a runner up in the Great Southern Development Commission Prize in 2019. She intends on documenting the abundance of plastic on the south coast in the coming decades as she expects the abundance to increase in her lifetime.

Assessing and managing the fate of reclaimed wastewater in Perth's deep aquifers.

Dr. Henning Prommer

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Groundwater replenishment of deep aquifers with highly treated, reclaimed wastewater has become an important tool to secure Perth water future. This presentation will give an overview of the geochemical investigations that have accompanied the development of this water source over the last 20 years, with a particular focus on the role that numerical modelling has played on assessing and managing the geochemical response to the injection of the recycled water from early laboratory-scale experiments over the analysis of the Groundwater Replenishment Trial (GWRT) to the use of reactive transport modelling to assess injectant amendments that will minimise the risk of metal mobilisation.

Monitoring of heavy metals contamination in near-shore marine environments using a novel bio-archive: Large benthic foraminifera *Amphisorus hemprichii*

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The release of heavy metals (HMs) into the coastal environments due to increasing anthropogenic activities poses a severe threat to local marine ecosystems and food chains. While some heavy metals may serve as essential nutrients for plants and animals, at elevated concentrations most are toxic and hazardous. Therefore, heavy metal pollution in coastal waters is one of the major environmental concerns making it imperative to develop reliable proxies for quantification of concentration levels. Shell geochemistry of marine calcifiers are increasingly utilised to monitor HM contamination in the coastal waters to overcome limitations from traditional monitoring methods (e.g., using water, sediment and marine biota samples). Heavy metal quantification studies were carried out using culture experiments with live juvenile specimens of the large benthic foraminifera *Amphisorus hemprichii* collected from the subtropical waters of Rottnest Island. This species was primarily selected because of their high abundance and common occurrence along the Western Australian and other Indian Ocean coastlines. The new calcitic tests of *A. hemprichii* formed during the culture experiments were characterised using LA-ICP-MS. The partition coefficients for Pb, Mn, Ni, and Cd

obtained from the culture experiments were applied to fossil *Amphisorus hemprichii* specimens picked from a sediment core from the Cockburn Sound industrial area to determine paleo-seawater HM concentrations. Partition coefficients obtained from culture experiments and their application to foraminifera extracted from a sediment core, now enable this naturally occurring bio-archive to be utilised as a quantitative monitor of anthropogenic HM pollution in present-day as well as past near-shore marine environments.

Mobility of contaminants in global supply chains: how the AgriFood industry can limit industry damage in outbreak events.

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Our food supply chains have consumers often connected, unknowingly, to other countries and other groups of people. What do these supply chains deliver us? What risks do they represent? This presentation will provide some insight into the complexity of global supply chains, why they are so important to us and also how they connect us to risks that are out of sight and often out of mind. Consider the food and agriculture supply chain; contamination with nasty bacteria, either from food production or manufacture in our food, anti-microbial resistant bacteria from intensively farmed animals in another country, fertiliser containing heavy metals from another continent contaminating locally grown grain or pesticides banned in one country used in another with residues in the final products.

The presentation will look at a number of specific examples and root causes of such issues. It will showcase how supply chains take what could be isolated risks and make them into public health crises. For example, the US continues to be challenged with bacterial contamination of lettuce and loose-leaf greens. The regular occurrence of mixed land and the complexity of modern agricultural practices have resulted in vulnerable agrifood supply chains that are seeing repeated instances of contaminants, pollutants and harmful bacteria making their way down the chain and to the consumer, unidentified.

Additionally to the health implications for consumers, the impact of these events on supply chains can be disastrous and widespread. Industry-wide recalls are not uncommon, and entire supply chains have been immobilised resulting in economic and reputational damage to once robust sectors.

The next step for the agrifood industry is to explore new solutions that can make their current screening and traceability systems more accurate and efficient, especially in sectors where produce from multiple sources is unlabelled and untraceable until it reaches the later processing stages. Creating visibility to the start of the supply chain – the true source and origin of our food – can be the key to mitigating the industry-wide risks related to contamination outbreaks.