

## A health journey from soil to nutrition

### Chemical elements for South Africa's future – Managing elements for nutrition and safety

**#elements4health #IYPT\_za #IYPT2019**

This is the **'Year of the Periodic Table of Chemical Elements'**, as declared by the United Nations (IYPT2019). At first glance, the periodic table appears to be just an arranged list of elements used as a tool in chemistry. However, it is also a lens through which to look at our world. Consider chemical elements with regards to health and nutrition. This takes us on a journey from soil, agriculture, water and heavy metal exposure through to human nutrition.

"Soil is the foundation of nutrition," says Mr Rankakwale Mampho, Deputy Director: Land Use and Soil Management, Department of Agriculture, Forestry and Fisheries (DAFF). Mr Mampho spoke at the **National Science and Technology Forum (NSTF) Discussion Forum** with the theme **Chemical elements for South Africa's future** (#elements4tech #IYPT\_za)

The event ran from 18-19 March 2019. The first day focused on **'Rare elements for new technologies'**. The second day looked at **'Managing elements for nutrition and safety'**. This NSTF Discussion Forum was held in partnership with the **South African National Convention Bureau** (SANCB), SA Tourism.

**Managing elements for soil and agriculture**  
Mr Mampho explained that soil is a national asset, particularly with reference to agriculture. He presented on **'The nexus of soil minerals, plant and human health'**.

He emphasised that all stakeholders need to understand that good nutrition starts with healthy soils. Soil mineral status affects food production which, in turn, affects food quality ie nutritional value and safety.

**South Africa has existing legislation for maintaining the production potential of land.** DAFF is also busy with a draft policy on Conservation Agriculture for improving the status of the soil. (Conservation Agriculture has three main principles: crop rotation and intercropping, permanent soil cover, and minimum tillage and soil disturbance.)

**The NSTF provides neutral collaborative platforms where issues and sectors meet**

- One of the National Science and Technology Forum (NSTF) functions is to hold **discussion forums**, bringing the private and public sector together to address important issues and engage with government policy.
- Feedback from these discussion forums is given to stakeholders.
- Recommendations are put forward to government as part of the **SET comments** lobbying efforts.

**Essential plant nutrients**  
Mr Harry Dube, Technical Advisor, Scientific Production: Agricultural Inputs Control, Department of Agriculture, Forestry and Fisheries (DAFF) explained the essential plant nutrients as follows:

- Structural plant nutrients are obtained from water and the atmosphere (hydrogen, carbon and oxygen)
- Macronutrients are divided into three primary macronutrients (nitrogen, phosphorus, and potassium) and three secondary macronutrients (calcium, magnesium, and sulphur)
- Micronutrients (chromium, boron, manganese, iron, copper, zinc, molybdenum, cobalt, and nickel)

"Good and productive soils maintain a healthy balance of these nutrients together with soil biota and organic matter."

**The lack of available water is becoming critical in South Africa.** Consider the impact of climate change and population growth. Projections from the Department of Water and Sanitation (DWS) show that water use is higher than water availability and the gap will increase.

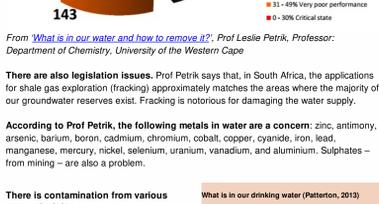
**We need to be able to treat water and remove undesirables from it.** says Prof Leslie Petrik, Professor: Department of Chemistry, University of the Western Cape. She presented on **'What is in our water and how to remove it?'**. She is also a 2018 NSTF-South32 Award Winner.

Contaminated drinking water can be explained by the following:

- Microbes and viruses ie living organisms that can cause disease
- Physical parameters, such as the pH of water
- Chemical parameters divided into inorganics (everything on the periodic table but carbon) and organics (carbon)

**Few of South Africa's wastewater treatment plants (WWTPs) are functioning at optimal level.** Prof Petrik says this is less than 10%. This is backed up by Ms Letshu Bungu, Water Quality Specialist Bulk Distribution: Rand Water. She noted that infrastructure at WWTPs is just being patched. Further to that, bigger municipalities are getting better treated water. Ms Bungu presented on **'Mineral content in drinking water and the health effects thereof'**.

This means that a huge load of microbes, inorganics, and organics are going into rivers and oceans. (Examples of organics are solids, like faeces, and chemicals in everyday use, like toothpaste and washing powder.)



From **'What is in our water and how to remove it?'**, Prof Leslie Petrik, Professor: Department of Chemistry, University of the Western Cape

**There are also legislation issues.** Prof Petrik says that, in South Africa, the applications for shale gas exploration (fracking) approximately matches the areas where the majority of our groundwater reserves exist. Fracking is notorious for damaging the water supply.

**According to Prof Petrik, the following metals in water are a concern:** zinc, antimony, arsenic, barium, boron, cadmium, chromium, cobalt, copper, cyanide, iron, lead, manganese, mercury, nickel, selenium, uranium, vanadium, and aluminium. Sulphates – from mining – are also a problem.

**There is contamination from various types of mining,** including coal, uranium, and gold. South Africa has treatment options. However, because treatment is an ongoing activity, the costs are high and thus treatments aren't applied consistently.

**There are also chemical treatments for organics and microbes.** There are three stages to the treatment process in WWTPs. South Africa generally processes to the second level. It's also important to note that the sludge from WWTPs is highly toxic. This needs to be managed.

Prof Petrik says that the sources of persistent pollutants include pharmaceuticals (eg medications), industry, and WWTPs. There are also pesticides and personal care products (like disinfectants and fragrances).

**Chemists don't design obsolescence in chemicals.** Now add that to the radically increased consumption of chemicals in the last few years. This is far more of a problem than plastics, says Prof Petrik.

These types of chemicals are having a significant impact. Examples include feminisation in fish populations, reproductive and developmental abnormalities such as endometriosis in humans, and persistent antibiotic resistance.

**What is in our drinking water (Patterson, 2013)**

Analyte	Description
Benzocaine	Anaesthetic
Paracetamol	Analgesic
TamoxifenAm	Anticancer
Fluocanide	Antifungal
Naloxic acid	Antibiotic
Sulfonamide	Antibiotic
Carbamazepine	Anticonvulsant /antiepileptic
Oxcarbazepine	Anticonvulsant /antiepileptic
Phenytin	Antiepileptic
Fluorazole	Antifungal
Telmisartan	Antihypertensive
Azoxil	Antihypertensive
Minoxidil	Antihypertensive vasodilator
Cinchonidine	Antimalarial
Cinchonine	Antimalarial
Ephedrin	Bronchodilator

From **'What is in our water and how to remove it?'**, Prof Leslie Petrik, Professor: Department of Chemistry, University of the Western Cape

**Prof Petrik says that wastewater treatment, even in the best operational system, is not adequate.** Removing pollutants etc from wastewater doesn't mean they are gone. We still have to deal with the very toxic sludge. Furthermore, desalination (reverse osmosis) is not 100% effective. While there has been a lot of work around advanced oxidation, it is also inadequate. A holistic system is needed for water for potable reuse ie a multi-barrier approach.

**No one lab does every test for the different types of toxins/pollutants in water.** Lab testing is also time consuming and expensive. Prof Petrik says it's important to decide what needs to be monitored, as well as the guidelines for acceptable levels of contaminants.

South Africans are supposed to be able to check their area's water safety. DWS has the **'Blue Drop My Water'** website. The information is supposed to be updated monthly. See <http://ws.dwa.gov.za/IRIS/mywater.aspx> and <http://www.dwa.gov.za/sites.aspx>.

**General heavy metal exposure in South Africa**  
Dr Renee Street looked at heavy metal exposure in South Africa, in particular lead, mercury, cadmium, and arsenic. She is a Specialist Scientist at the Environment and Health Research Unit, South African Medical Research Council (SAMRC). She presented on **'Heavy metal exposure in South Africa and related health risks'**.

Man-made sources of heavy metals include various industrial processes, mining, foundries, and the combustion of fossil fuel and gasoline. Toxicity depends on various factors, such as dose, route of exposure, and chemical species.

Dr Street says there have been successes. South Africa has phased out leaded petrol and lead paint regulations have been strengthened. However, there is an unfinished agenda particularly with the informal sector.

**Lead and arsenic have been found in urban garden soils.** The SAMRC conducted studies on contaminants in urban soil and found alarming levels. Research has shown that cottage industries play a significant role regarding these contaminants. Examples include subsistence fishing communities where waste lead is streed to craft fishing sinkers.

**Metals are also found in traditional medicines.** Dr Street says that ayurvedic medicine involves deliberate inclusion of minerals and metals. SAMRC research and testing have also found metals in African traditional medicine, says Dr Street.

**A more recent study by the SAMRC is investigating multi-metal exposure from artisanal cookware as a potential public health threat in South Africa.** In developing countries, informal recycling of metals is widespread as a way to make money. An example is the casting of liquid aluminium (from scrap metal) into cooking pots.

**Legislation and policies regarding human nutrition**  
There is a significant amount of South African and international legislation around human nutrition. (This ranges from health, food safety, and food security to medicines.) For further details see **'Legislation and policies regarding human nutrition'** by Ms Penny Campbell, Senior Manager: Food Control, National Department of Health. South Africa's legislation covers biological and chemical safety (including heavy metals), food composition, and food labelling legislation.

Speakers can be contacted through the spokesperson, **Ms Jansie Niehaus**. Video clips with the full presentations can be found on the **NSTF website**.

**About the NSTF**  
The National Science and Technology Forum (NSTF), established in 1995, is a broadly-representative stakeholder body for all SET and innovation organisations in South Africa, which seeks to influence policy formulation and delivery.

The NSTF Awards are unique in SA, recognising the outstanding contributions of individuals and groups to SET and innovation.

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