



THE UNIVERSITY OF
NEWCASTLE
AUSTRALIA



Fighting the unseen enemy: the global threat of soil and water contamination

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www.crcCARE.com

Outline

- Glinka Prize – inspiring
- The journey
- Soil: the fragile and productive interface
- The Unseen enemy and impacts
- Challenges to sustainable management of unseen enemy
 - Awareness
 - Collaboration
 - Resources
 - Going global



Great inspiration for
fighting for healthy soil

Thank You!



**GLINKA
WORLD
SOIL
PRIZE**

Fijian by birth

- Relocated to Australia in 1989



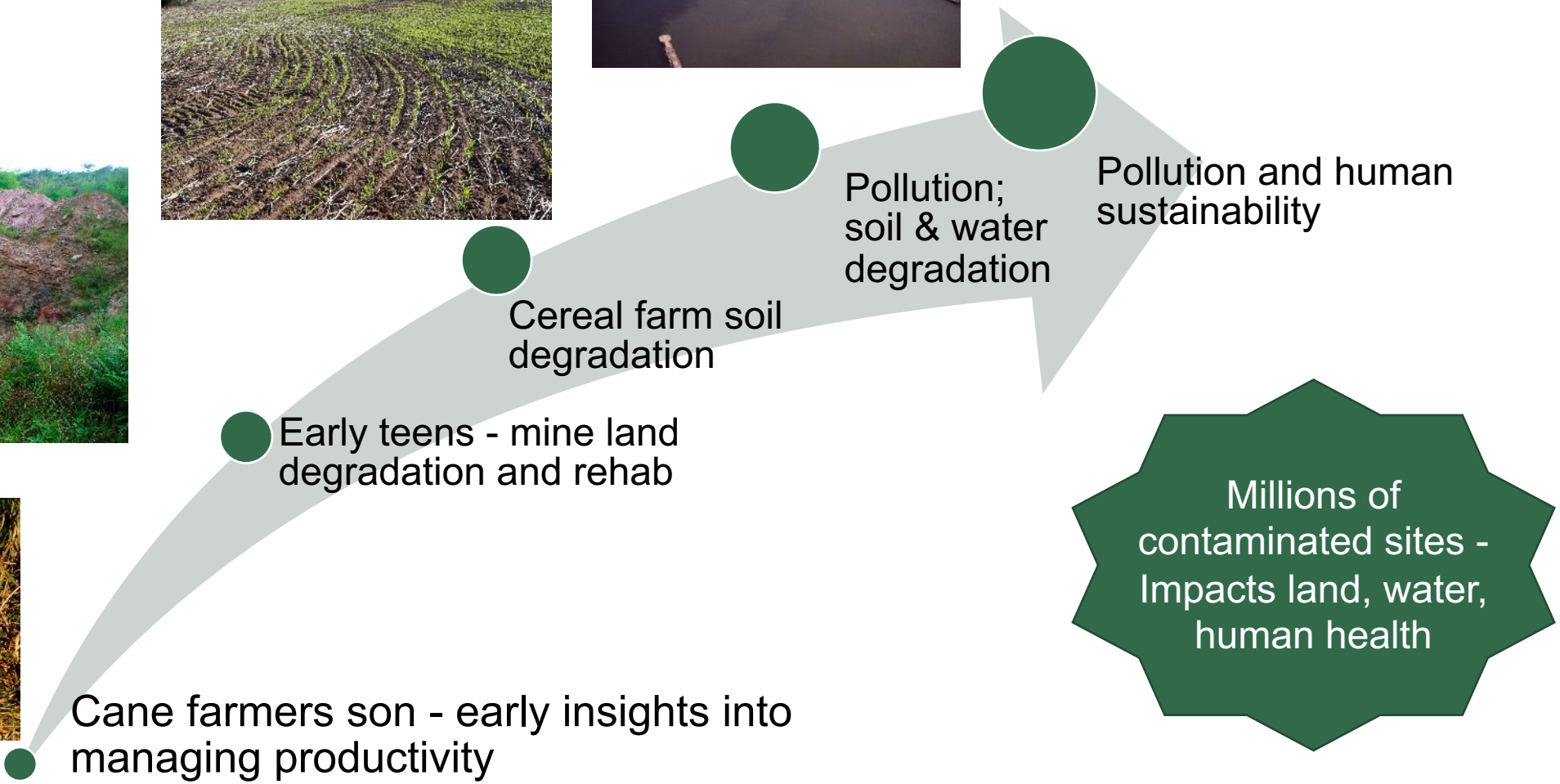
The Journey



Photo: Rajaee et al., (2015)

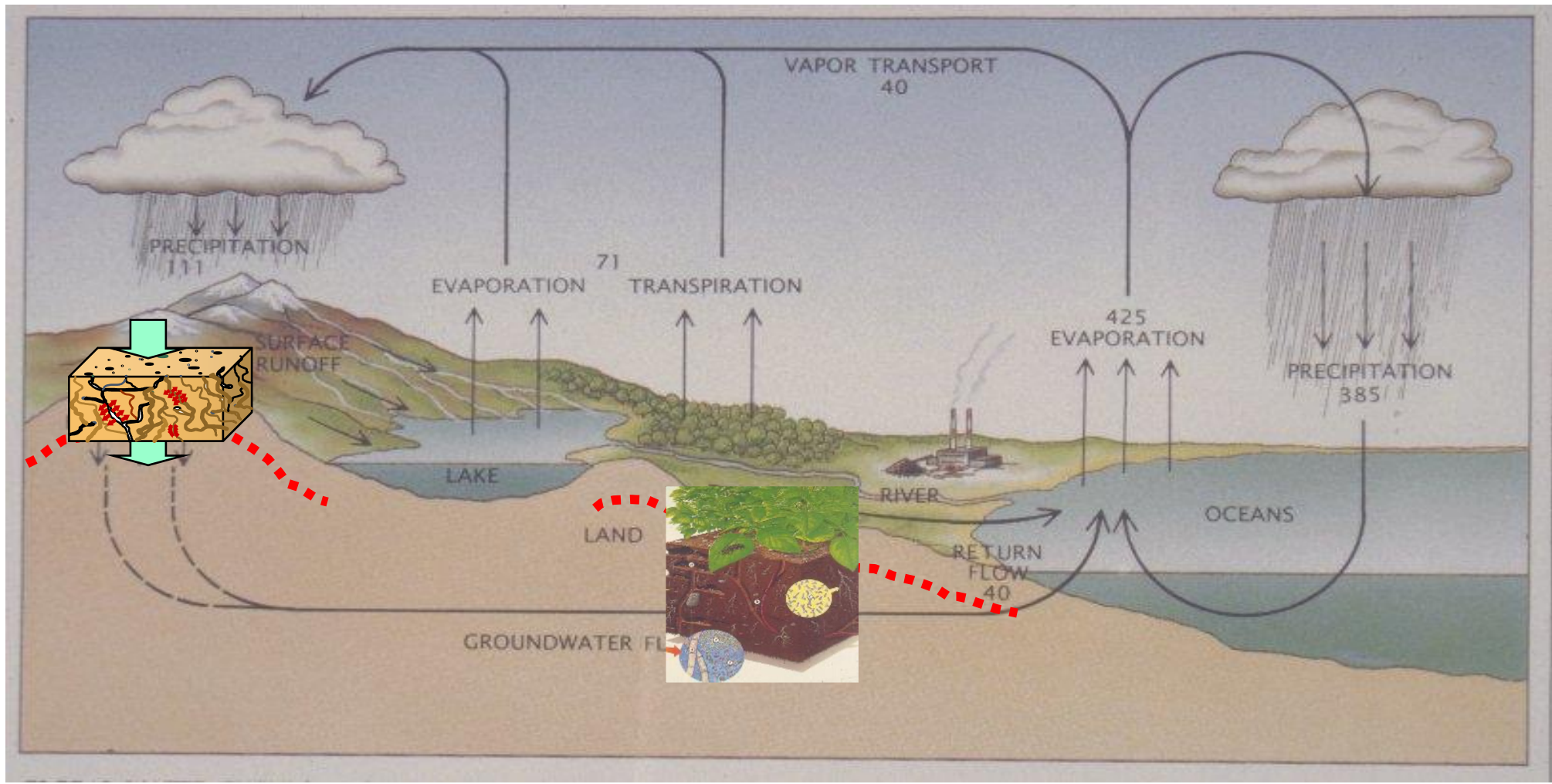


Photo: ADB



Soil: the fragile & productive interface

The first filter of Earth's water

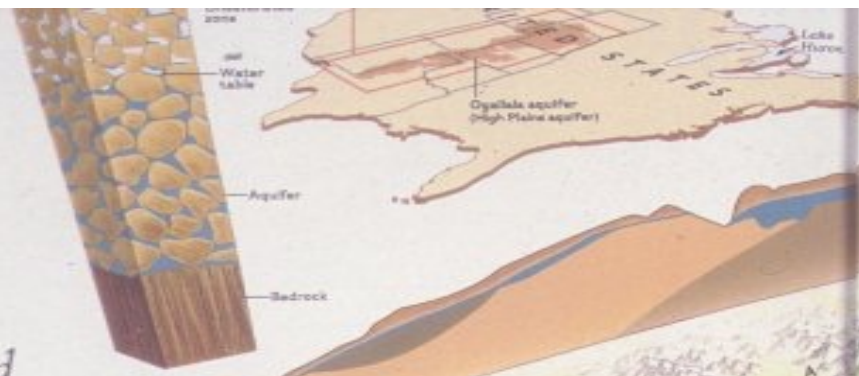


Groundwater - a resource in need of protection

Soil - the first filter



Close-up
Like a bucket full of wet gravel, an aquifer consists of a porous medium filled with water trapped by a bedrock bottom. Precipitation and surface streams recharge the supply. Most Ogallala water has been held within the formation for a few millennia.



The great underground sponge

OVER EONS, rain eroded the Rocky Mountains, washing downstream millions of years' worth of gravel and sand. Those sediments soaked up rain and snowmelt, holding enough water to fill Lake Huron.

While the Ogallala is the region's most abundant aquifer, geologists have mapped others above and below it and term the total supply the High Plains aquifer. The names are used interchangeably by most people.

Not until the 1950s was the Ogallala aquifer first massively tapped by advanced irrigation technology, including center-pivot sprinkler systems, each designed to water about 130 acres. After 20 years of pumping, a resource that had once seemed infinite began, in some places, to look like a well running dry.

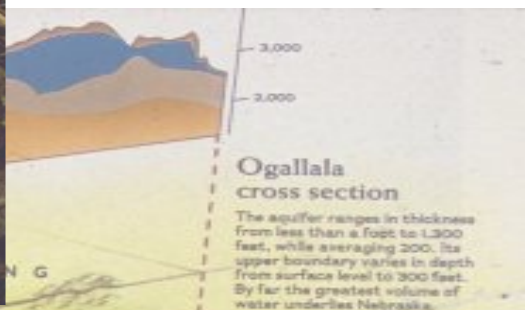
Better management practices are easing fears that the aquifer will be depleted within several generations. Still, in most regions pumping continues to remove more water than rain can replace each year.



Groundwater withdrawals, per acre-foot, 1990

0.00-0.01
0.02-0.09
0.10-0.24
0.25-0.49
0.50-0.99
More than 1.00 acre-foot

Scale varies in this perspective.
SOURCE: U.S. GEOLOGICAL SURVEY
PRINTING BY DEAN SARTORI



Ogallala cross section
The aquifer ranges in thickness from less than a foot to 1,300 feet, while averaging 200. Its upper boundary varies in depth from surface level to 300 feet. By far the greatest volume of water underlies Nebraska.

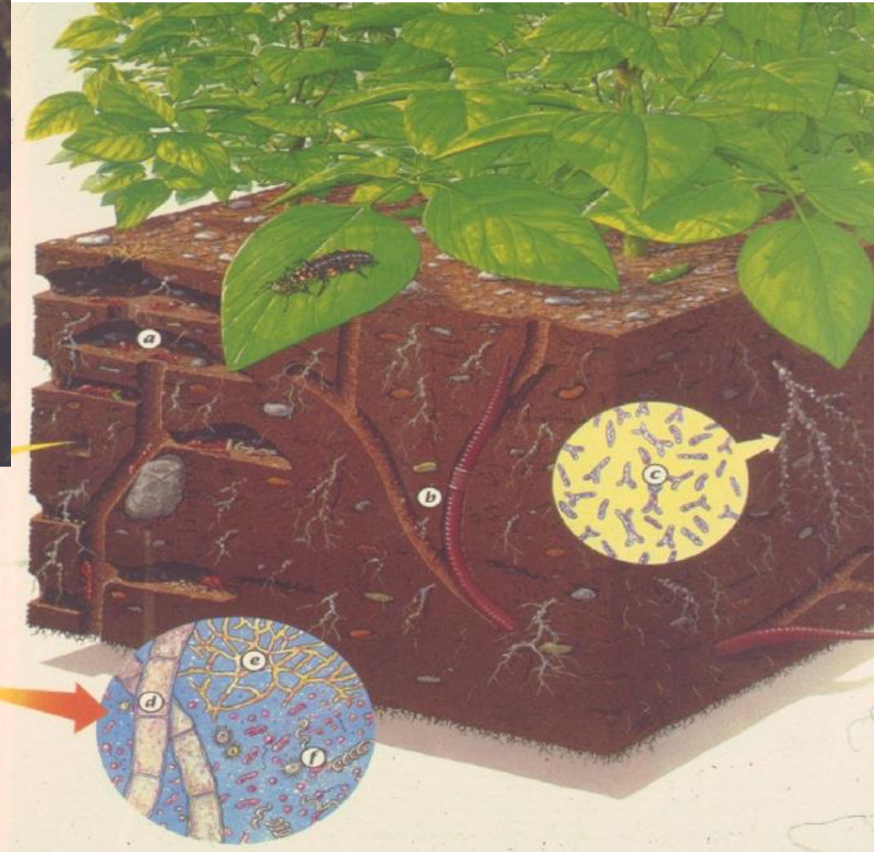


Using the aquifer
More than 90 percent of water pumped from the aquifer is used to irrigate crops, and withdrawals equal 30 percent of the total U.S. groundwater used for irrigation. Principal crops are cotton and grains, especially sorghum, corn, and wheat. Grains provide feed for High Plains cattle operations, which amount to about 40 percent of the nation's feedlot beef output.

Changing groundwater levels
From the 1940s to 1990 the average water level in the High Plains aquifer rose 7.5 to 14.9 feet in some parts of Texas. During the 1950s the level declined only an additional foot—a result of increased rain and snow, water management, and new technology.

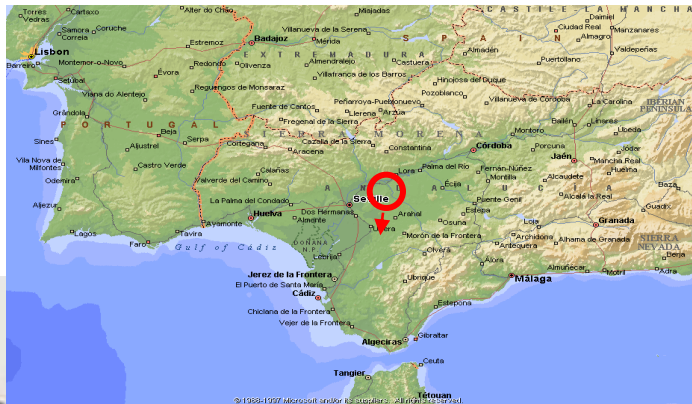
Clothier (1999)

An environmental imperative: Clean & functioning soil



Google images

Soil Contamination



Google images

Guadiamar River, Spain
A tailings' dam break, Aznalcollar



Exposure to an unseen enemy: arsenic

Children suffering from arsenicosis following sustained exposure to arsenic in water and food products

Human
Health



MANY DISASTERS: FEW SOLUTIONS



Arsenic

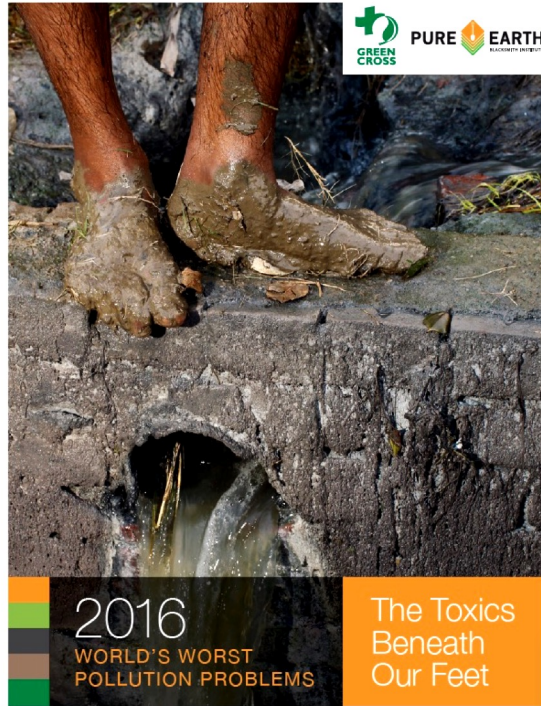
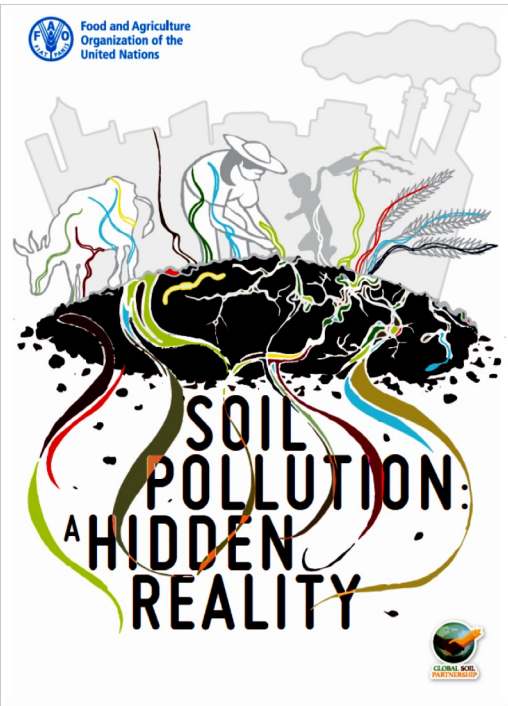
EXPOSURE TO EDC- IMPACT ON ECOSYSTEM HEALTH



Catfish with deformities (above)
and tumors (right)



Program Review, Feb. 25 – 28, 2002



Degraded vs Healthy Soil: the unseen!



ref: FAO and UNEP 2021; Pure Earth, 2016

Pollution the unseen enemy- convincing decision makers

- Not in my backyard (1990s)
- Let's not talk about it
- We are a clean and green country
- How to convince decision makers that pollution is destroying our ecosystem and poses a risk to humanity?
- Awareness

"There's something in the water."
— Betty Osceola

UNSEEN ENEMY

Google image


It's invisible, but the mercury assault on the Everglades is beginning to have visible effects on wildlife and human beings.

BY ROGER WILLIAMS

Special to Florida Weekly

ON ANY GIVEN DAY, STRAIGHT-LINE CANALS flanking narrow roads that thread the Big Cypress National Preserve and Everglades National Park host scores of pole fishers.

Shore-bound or boat-mounted, they hoist both pleasure and supper from dark waters often visibly pocked with alligators and adorned with attendant wading birds. Human and other animals have foraged here through 5,000 years of seasons wet and dry, hunting and fishing in a slow-motion water world sliding eternally south, from the big fresh splash of Lake Okeechobee to the fecund salt shallows of Florida Bay.



COURTESY PHOTO / USGS

Mercury sampling in the Everglades using clean techniques.

SEE MERCURY, A12 ►

Forces, consequences & legacies

- **Economic**

- Lost production
- Cost of clean-up
- Employment
- Polluter pays
- Increased costs locally



- **Socio-legal**

- Litigation
- Loss of business confidence
- Regional & infrastructural changes
- Social disruption
- Job losses
- Costs-of-living

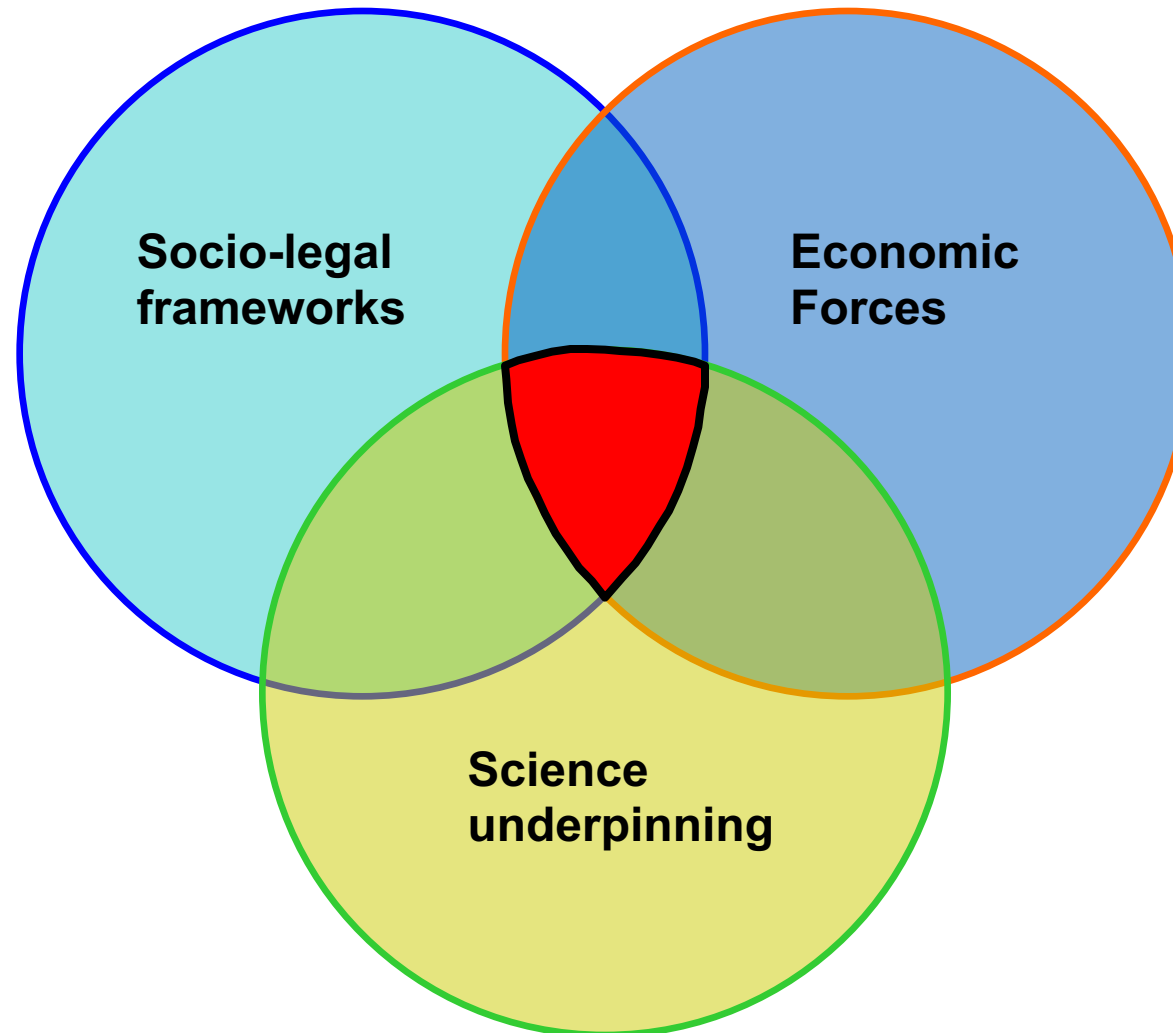


- **Science & technology**

- Detailed understanding
- Large-scale solutions sought.
- Bioremediation
- Remediation technology
- Prediction & risk assessments



A clean, healthy & productive environment: the balanced goal

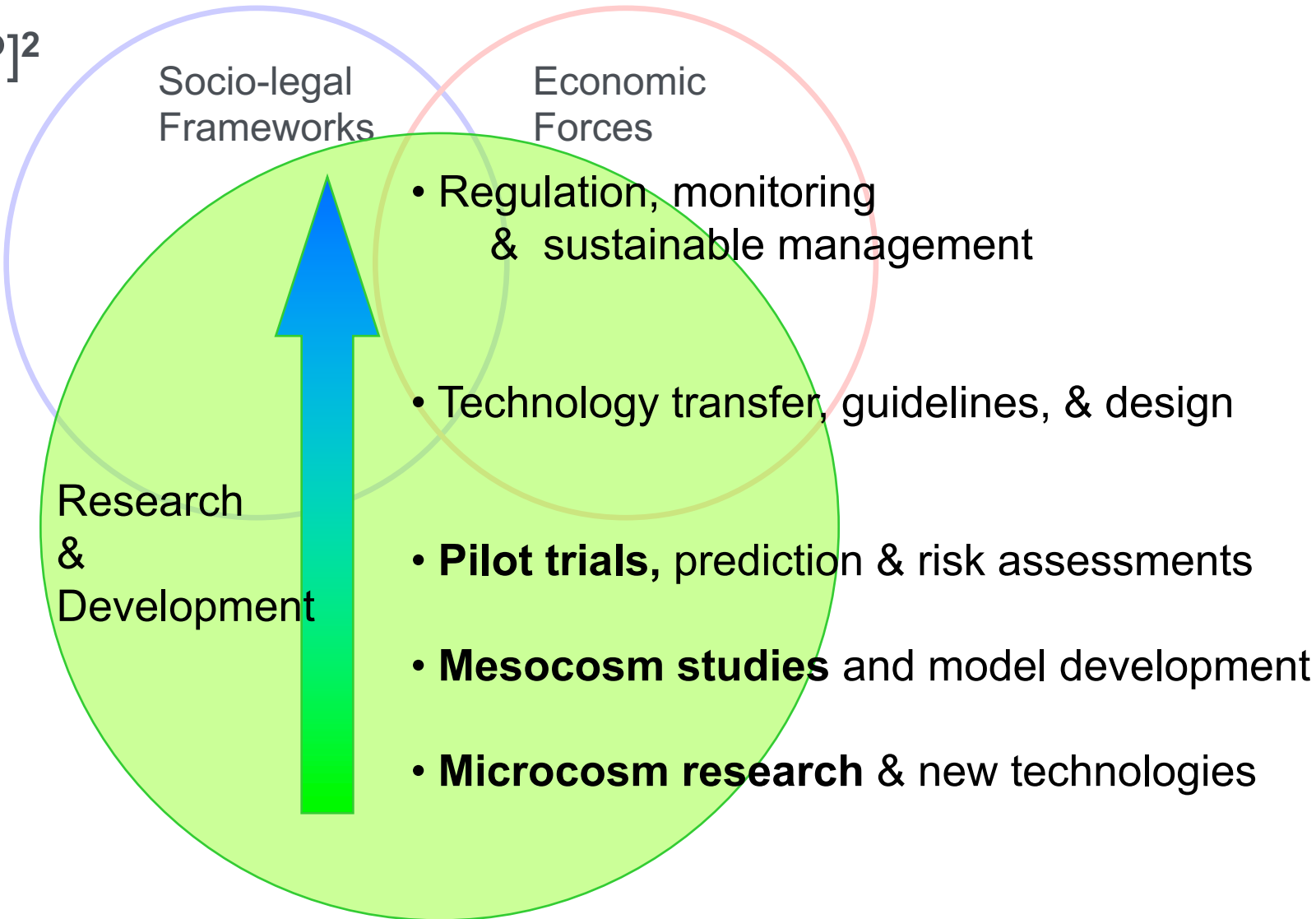
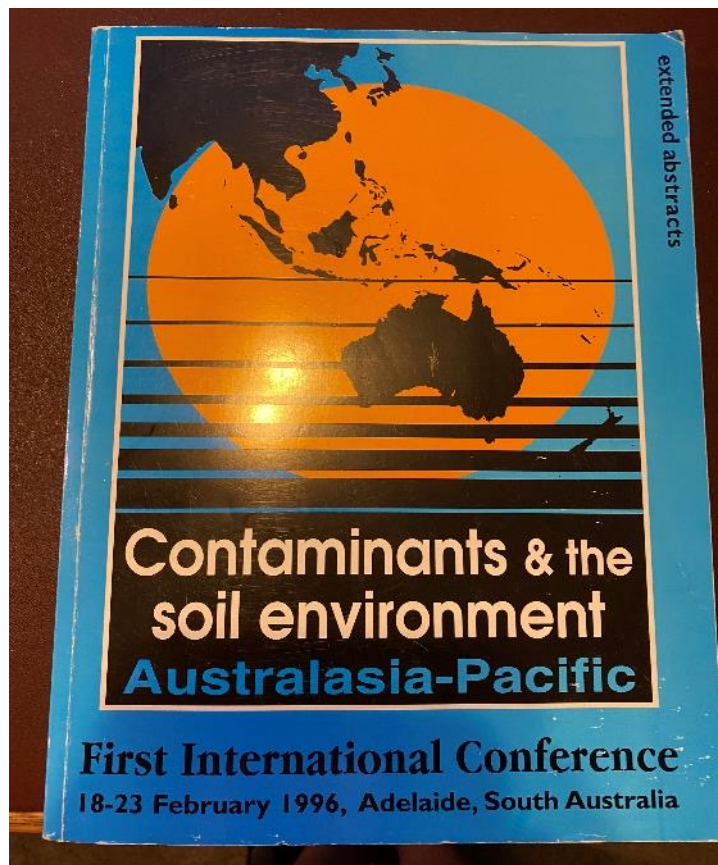


Clothier

Soil contamination research in Asia & the Pacific (SCRAP): a pathway

Creating awareness

[SCRAP]²



Two futures for SCRAP

New measurement devices
& monitoring technologies ...

... and modelling tools for
risk assessments

The diagram illustrates the integration of environmental monitoring and modeling. On the left, a tree with roots is shown in a soil profile. A laptop displays a graph, and a well with sensors is positioned in the soil. A magnifying glass focuses on a soil cross-section with blue arrows indicating flow. On the right, a person is shown working at a computer. A blue thought bubble contains mathematical equations for mass balance and reaction rates.

$$\theta_m \frac{\partial C_m}{\partial t} + \theta_{im} \frac{\partial C_{im}}{\partial t} - \theta_m D_s \frac{\partial^2 C_m}{\partial z^2} - v_m \theta_m \frac{\partial C_m}{\partial z}$$

$$\frac{q_f}{q_{0f}} = z^{\beta} \frac{q_f}{q_{0f}} = (1^{\gamma} \chi^{\delta} + \rho^{\epsilon} \theta \Omega + 2^{\eta}) - (\rho^{\lambda} \epsilon^{\delta} \chi^{\delta} + \rho^{\zeta} z^{\beta} \theta \gamma + b^{\nu} + D^{\nu})$$

$$\frac{\partial NH_4^+}{\partial t} = \left[\frac{N_f}{C_L} - \frac{1}{r_o} \right] K_L \cdot C_L + K_H \cdot N_H$$

$$\frac{\partial NO_3^-}{\partial t} = - \frac{f_E}{r_o} K_L \cdot C_L$$

Soil remediation: individual to global: Awareness and networking

Over 950 peer-reviewed articles,
regulatory and industry reports

Brought remediation science and
practitioners together

e.g. International CleanUp series



Fiji – addressing sugar
cane/soil productivity

WE PRODUCE & DISPOSE OF 400 MILLION TONNES

HAZARDOUS WASTE EVERY YEAR

LESS THAN 1% THAT'S THIS MUCH!

10 MILLION POTENTIALLY CONTAMINATED SITES

HAVE BEEN PROPERLY ASSESSED OR REMEDIATED

CLEANUP
CONFERENCE

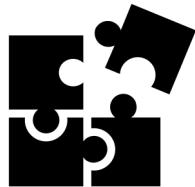
GLOBAL CLEANUP CONGRESS
INDIA 2018

INTERNATIONAL CLEANUP CONFERENCE
ADELAIDE 2022

GLOBAL CLEANUP CONGRESS
KUALA LUMPUR 2022

Addressing the issue: one and the team

Alone we can do so little! – Helen Keller



In over 3 decades, I have tried to contribute
more than soil science & innovation



Communicating and building capacity



- Launched Network on Contamination in 1996
- Expanded the network to globalCARE in 2013
- Network focuses on capacity building

Remediating chromium contaminated farms in India

Delivering field based solutions requires more than science:

- (a) Resources
- (b) Regulatory
- (c) Transdiscipline team
- (d) Listening
- (e) Community



Raising funds to tackle arsenic contamination

- Assessment and monitoring of arsenic in soil and water
- Developing innovative technologies for managing
- Establishing arsenic mitigation centre



Australian High Commissioner, Ms Lorraine Barker addressing as the chief guest, the inaugural function of the Bangladesh-Australia Centre for Arsenic Mitigation, in Dhaka Community Hospital yesterday.

Arsenic mitigation centre inaugurated in city

BSS, Dhaka

An arsenic mitigation centre for research and analysis of water contamination and its affects in life and crops was inaugurated yesterday at the Dhaka Community Hospital (DCH) at Moghbazar in the city.

Australian High Commissioner to Bangladesh Ms Lorraine Barker opened the centre, known as Bangladesh-Australia Centre for Arsenic Mitigation with financial assistance from the Aus-Aid.

Speaking on the occasion Lorraine stressed for creating public awareness and capacity building to face the challenges of arsenic problem and its mitigation.

This new centre, first of its kind in the country, will preserve all documents, research outcome and information related to arsenic contamination in ground water and its mitigation as well as uses of safe surface water for drinking purpose.

Explaining the nature of the arsenic problem, the Australian High Commissioner said it was not a problem of a specific country but a global phenomenon. The Australian government is extending financial support to this project along with two other arsenic related projects that were posing threat to public health.

Present on the occasion were LGRD joint secretary Sayeedur Rahman, Prof Quazi Moniruzzaman, First secretary of the AusAid Ms Jannet Donnelly, AusAid Technical Adviser Peter Scaife and Director of Bangladesh-Australia Center for Arsenic Mitigation project Peter Robson.

Terming access to arsenic-free food and drinking water as 'fundamental human rights', Lorraine said, arsenic contamination shows how chemical elements in life-saving water can turn it into a killer material.

Pointing to the Ganges and Mekong delta as arsenic prone, she said

India, Bangladesh, Vietnam, Cambodia, Thailand and many other countries of the region are facing acute health threats arising out of it.

Its impact on human body can create cancer. Crops grown with support from arsenic contaminated water may result in reduction of yield and malnutrition. In Bangladesh, much surface water causes different diseases.

She hoped that the newly launched centre will provide laboratory support to research and field investigation in combating the problems and help develop actions and awareness to arsenic poisoning.

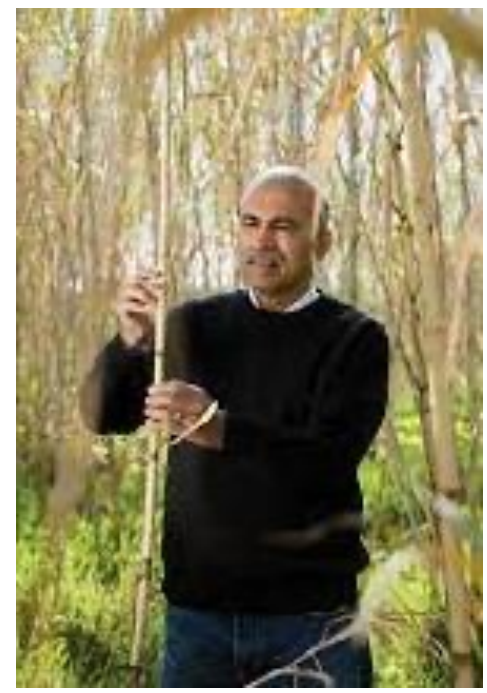
Earlier, Prof Mahmudur Rahman in his keynote speech said, the centre would act to store, develop and disseminate all information regarding arsenic problems. It will remain the focal point in analysing public health, environment and human risk factors that may arise out of this silent killer from water.



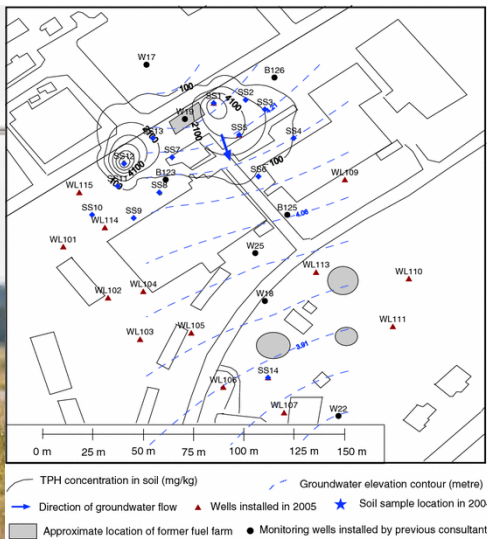
Remediating degraded soil



Nearly 20 years of research and regulatory framework contribution for site assessment and remediation;
globalCARE



ACIAR-funded projects including other sponsors to remediate metal polluted sites across India, Bangladesh, Malaysia, Thailand



Led research in a long-term soil and groundwater remediation project in contaminated airbases

Enabling action by national and international government



Rehabilitating ecosystem services!



Information sharing

A voice for
pollutant-free, healthy soil

What's required?

- Communicate-Awareness
- Join the dots
- Join hands via collaboration
- Build capacity
- Access/raise resources
- Persevere-persist
- Deliver excellence on all fronts



Why soil pollution is crucial to assess, monitor and manage?

Unseen and hence not assessed?



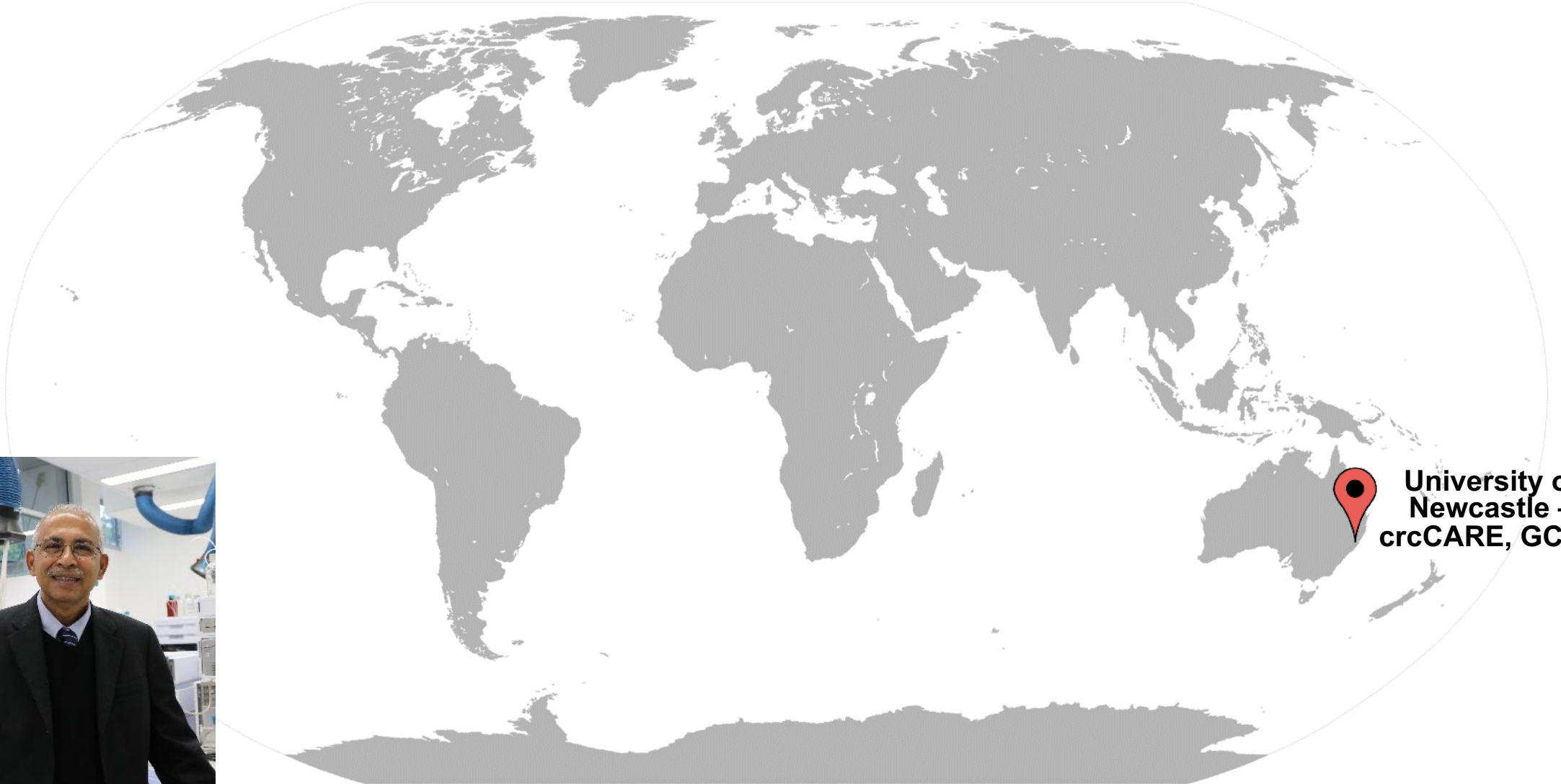
Fundamental for life!



Source of our food



Global Contamination Assessment and Remediation of the Environment



**University of
Newcastle –
crcCARE, GCER**

Soil pollution hurts One Health.....



1 NO POVERTY 	2 ZERO HUNGER 	3 GOOD HEALTH AND WELL-BEING 	4 QUALITY EDUCATION 	5 GENDER EQUALITY 	6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY 	8 DECENT WORK AND ECONOMIC GROWTH 	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE 	10 REDUCED INEQUALITIES 	11 SUSTAINABLE CITIES AND COMMUNITIES 	12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION 	14 LIFE BELOW WATER 	15 LIFE ON LAND 	16 PEACE, JUSTICE AND STRONG INSTITUTIONS 	17 PARTNERSHIPS FOR THE GOALS 	

We need to work together to make soil safe and healthy

ACKNOWLEDGEMENT



Thanks to:



Team!

- Dr Bhaba Biswas
- Dr Brent Clothier
- Mr Adam Barclay
- The team members from 15 countries

INTERNATIONAL CLEANUP 2024 CONFERENCE: ADELAIDE

Sept 15-19, 2024, Adelaide South Australia

- 10th International Contaminated Sites Remediation Conference **combining 4th International PFAS Symposium**
- The largest conference in Asia–Pacific and one of the largest in the world
- Bringing together global remediation leaders from industry, government and academia
- **700- plus delegates** expected from across the globe
- **300-plus presentations** and numerous poster presentations



Thank you

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