Microbial transformation of arsenic

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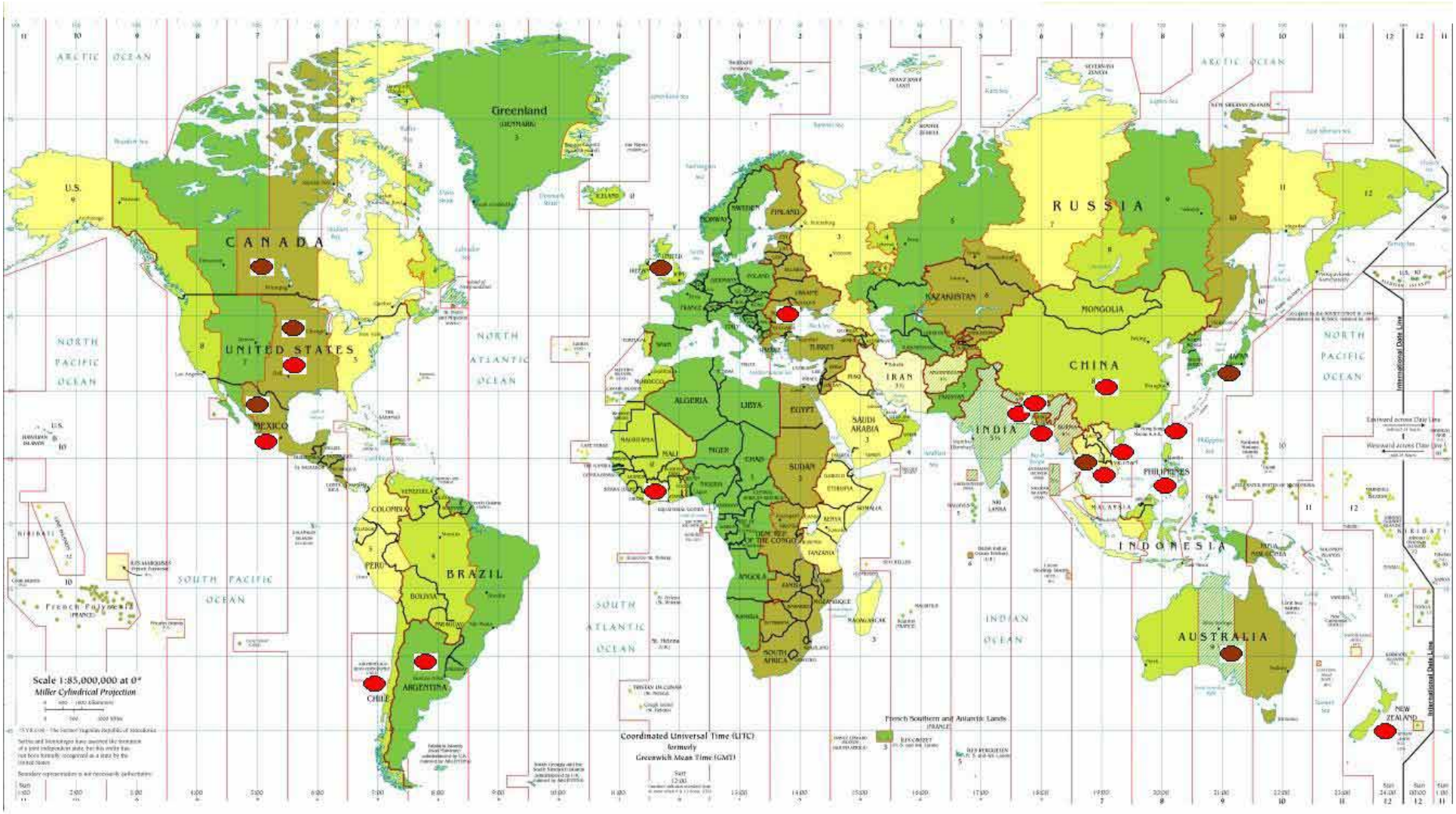
Background and Introduction



- **Arsenic contamination from natural aquifers**
- **Arsenic leaching problem from mine tailings**

Arsenic contamination of soil

- Continued cropping with arsenic contaminated irrigation water increases the extent of contamination in agricultural land
- A large amount of arsenic as high as 10 kg/ha per year is cycled through irrigated water in Bangladesh (DPHE/BGS 2000)
- Some recent studies observed considerable arsenic concentration in rice and vegetables grown on arsenic

Irrigating As contaminated groundwater by electrical pump

Bangladesh

2003 September, Photo taken by Ken Fukushi

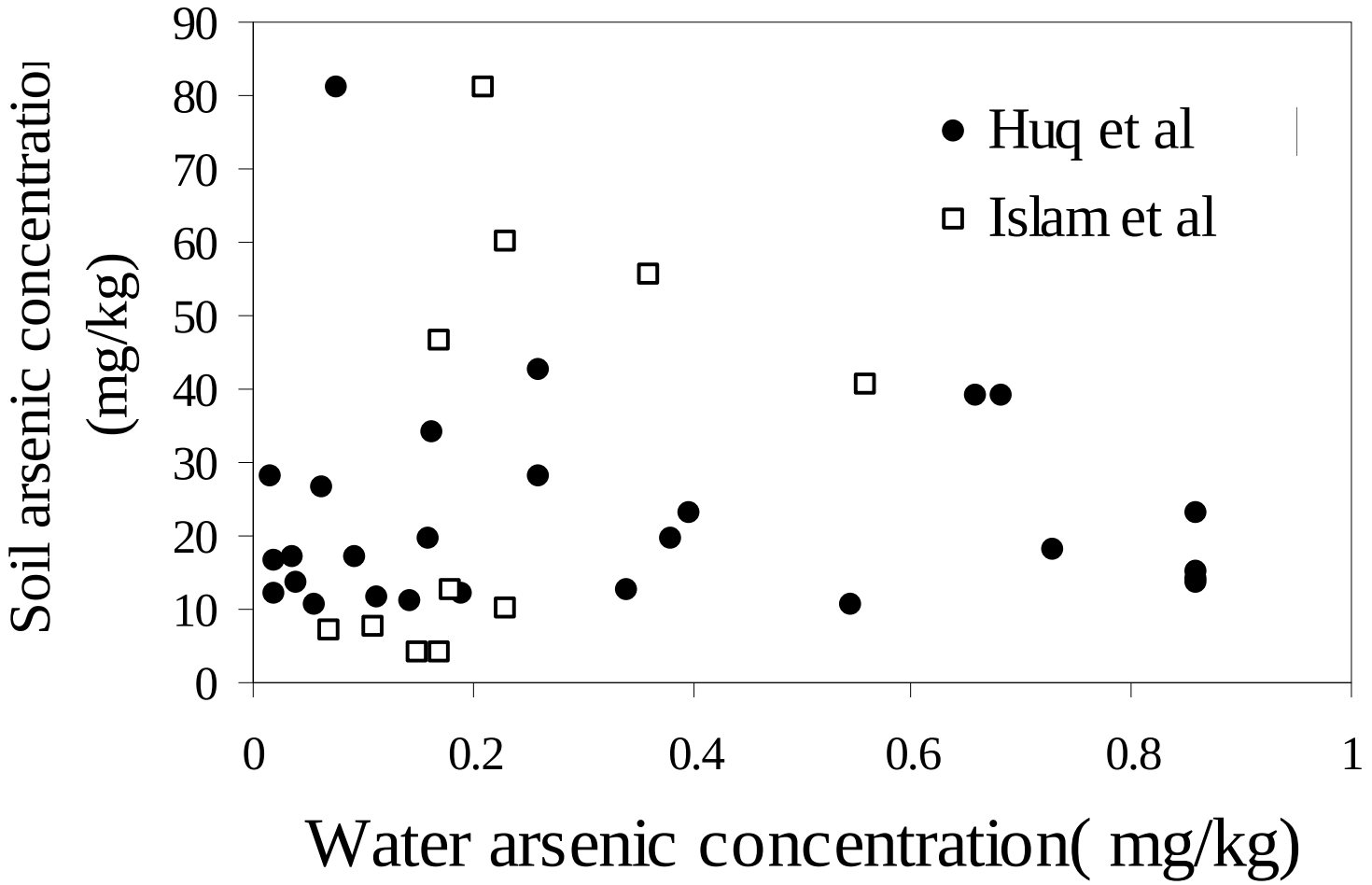
Red: Contaminated
Green: Not contaminated
(Bangladesh)

Arsenic Iron Removal Process (AIRP)

Bangladesh

2003 September, Photo taken by K. Fukushi

Relationship between arsenic concs. in soil and groundwater



Arsenic from mine tailing

Thailand

2000 October, Photo taken by Ken Fukushi

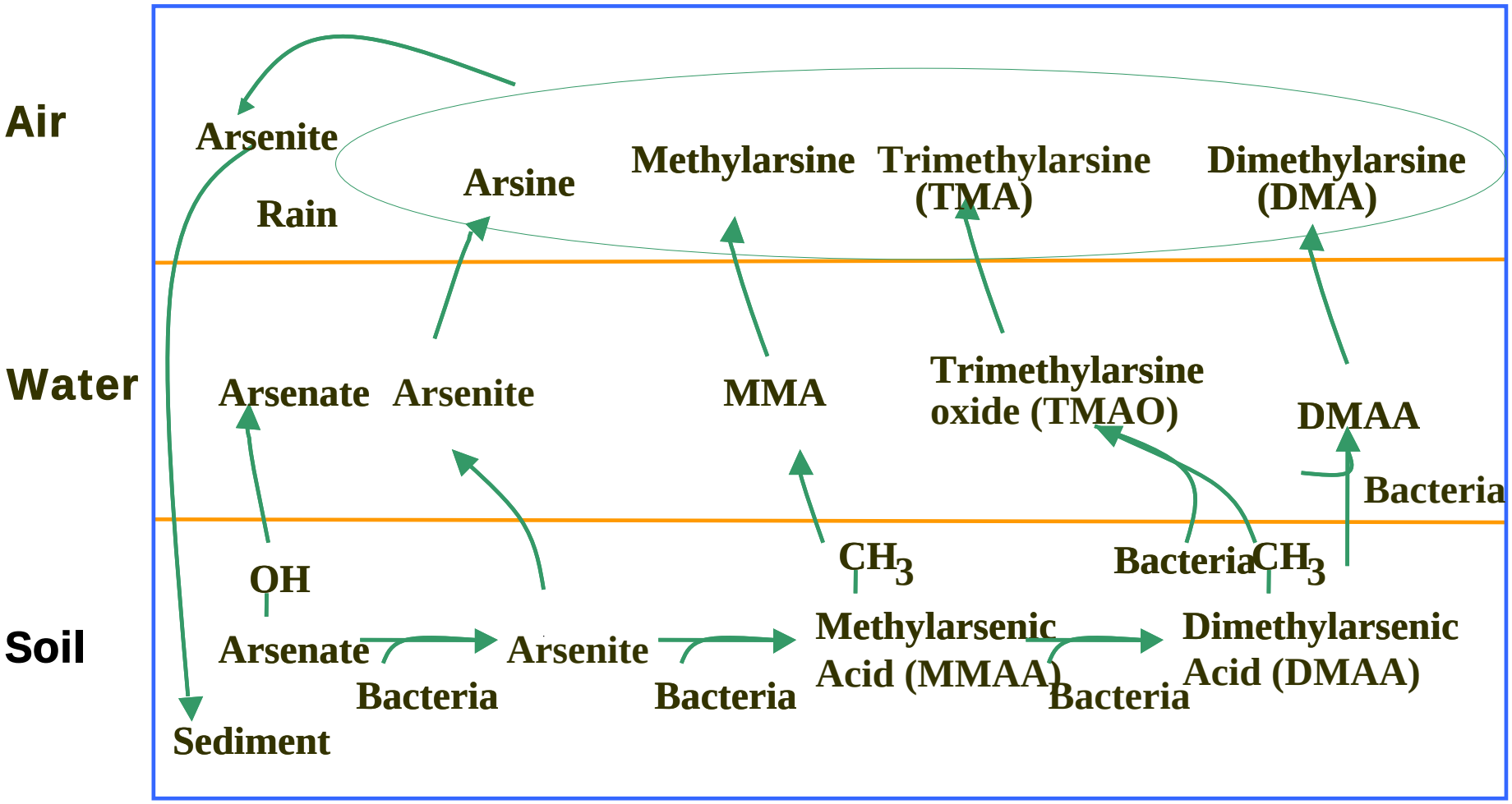

Polluted area


Polluted surface water

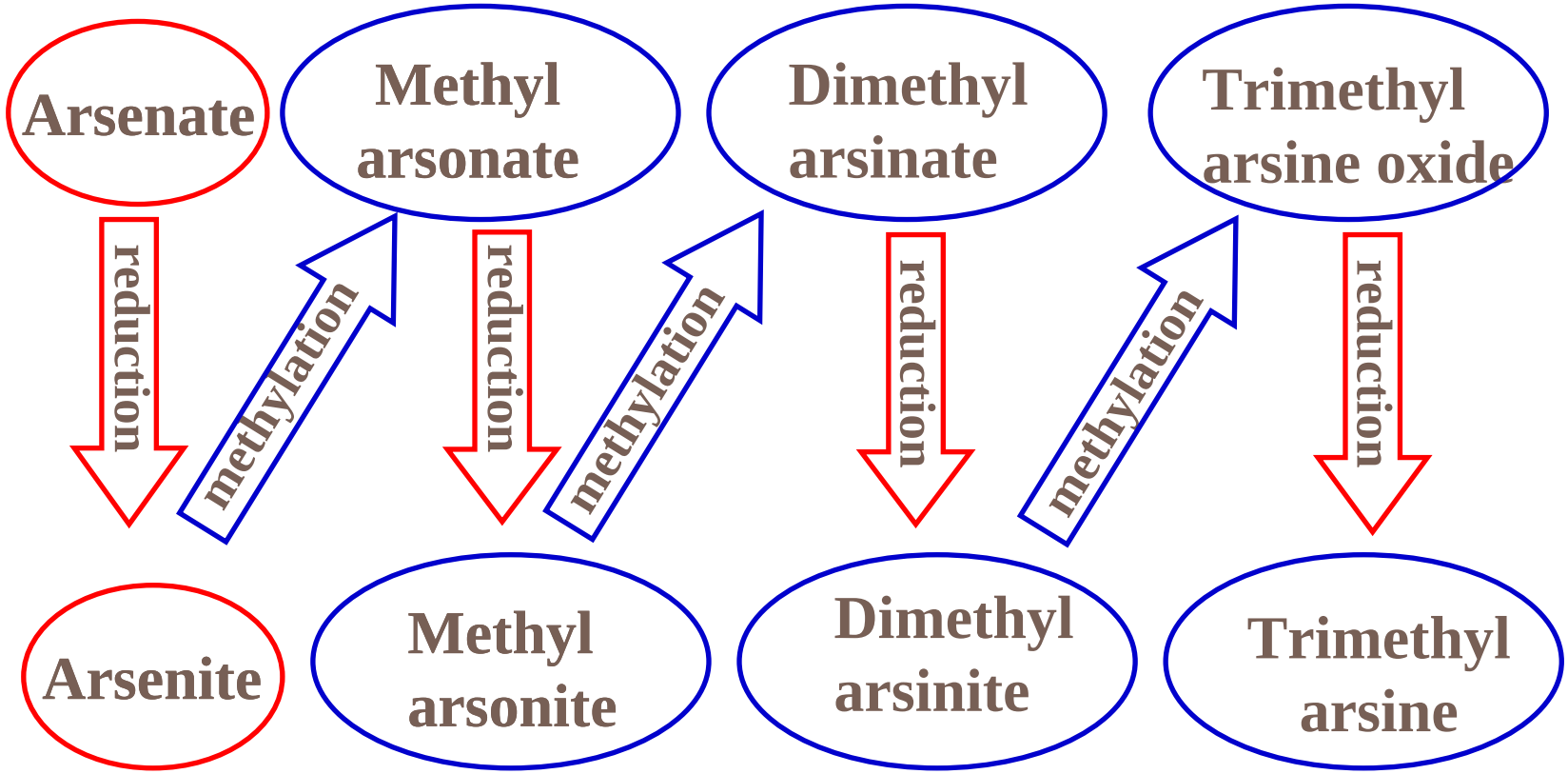

Polluted surface water


Polluted surface water
Thailand

Transformation of arsenic in natural environment

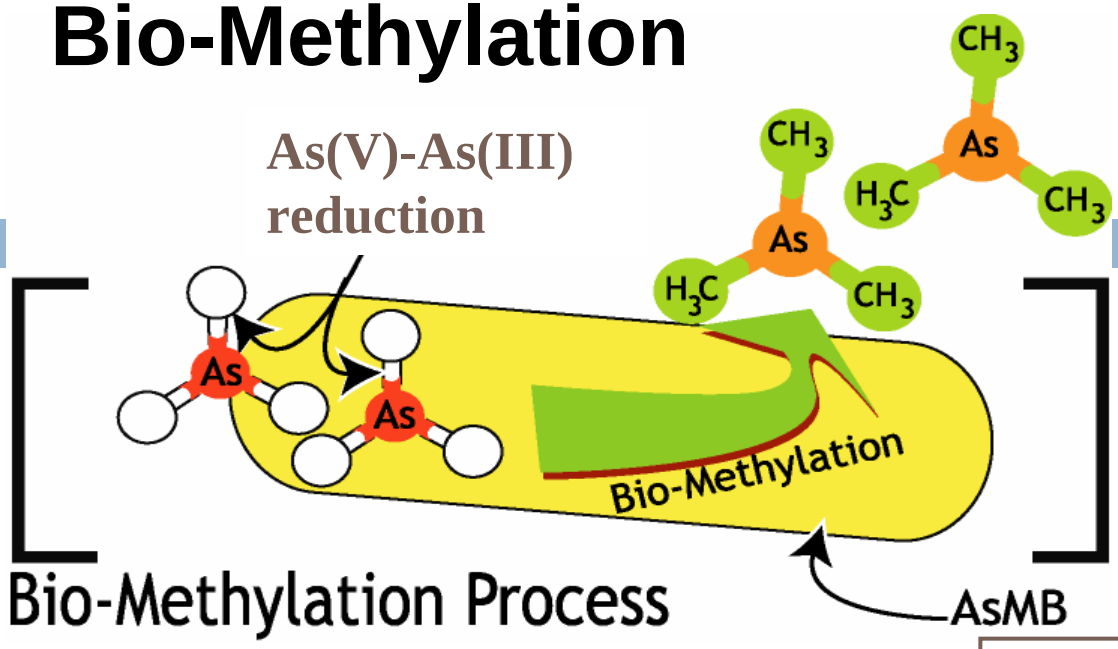


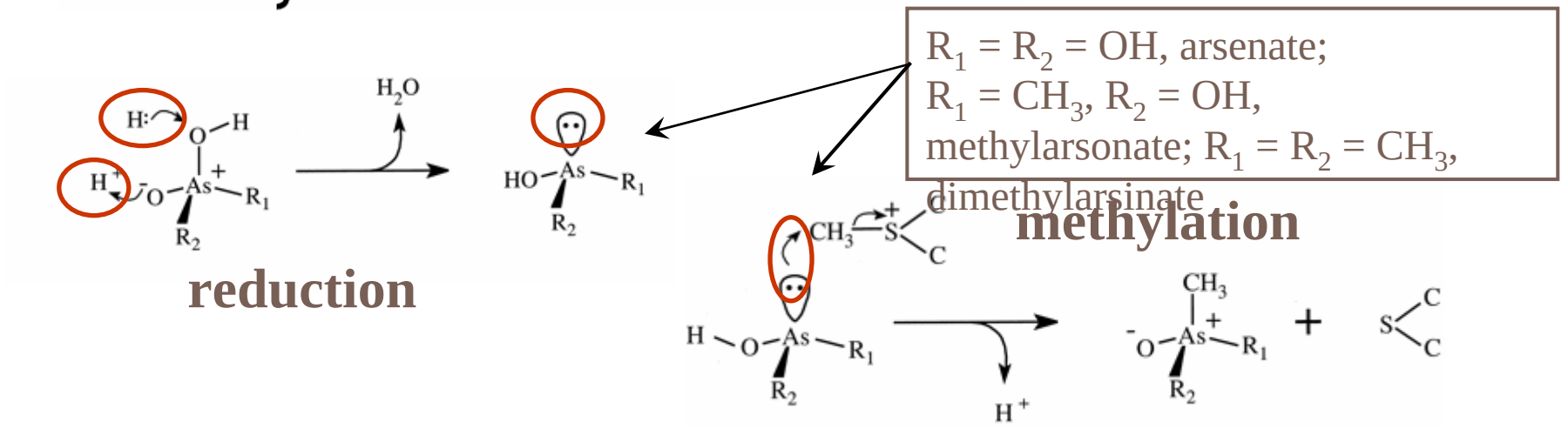
Bio-Methylation-mechanism



Proposed for *C. humicola*

Bio-Methylation





Glutathione (GSH) provides the electrons for reduction and probably methylcobalamin is the methyl donor for anaerobic microorganisms

APPLICATION FOR CLEANUP

- High efficiency of methylation
  - Up to 100 times comparing over the natural condition by mixed culture
  - Up to 1000 times comparing over the natural condition by pure culture1313
- Application examples
  - Soil
  - Sludge from water treatment
  - Other solids containing arsenic

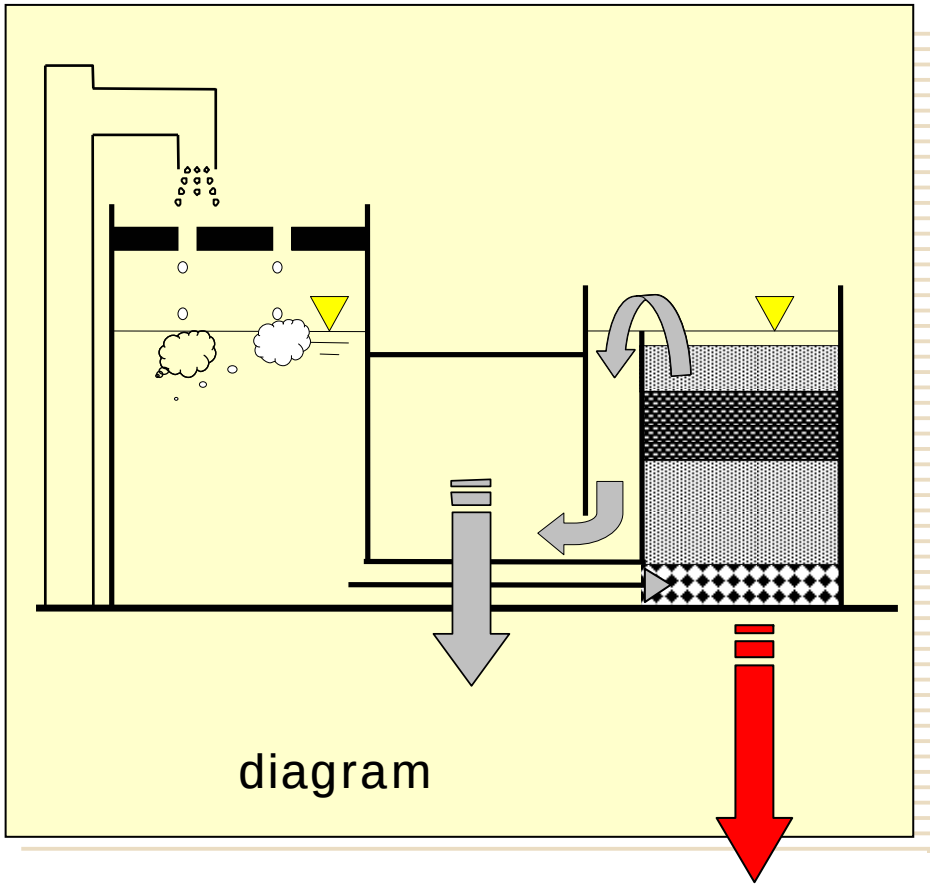
Arsenic Iron Removal Process (AIRP)

Bangladesh

2003 September, Photo taken by K. Fukushi

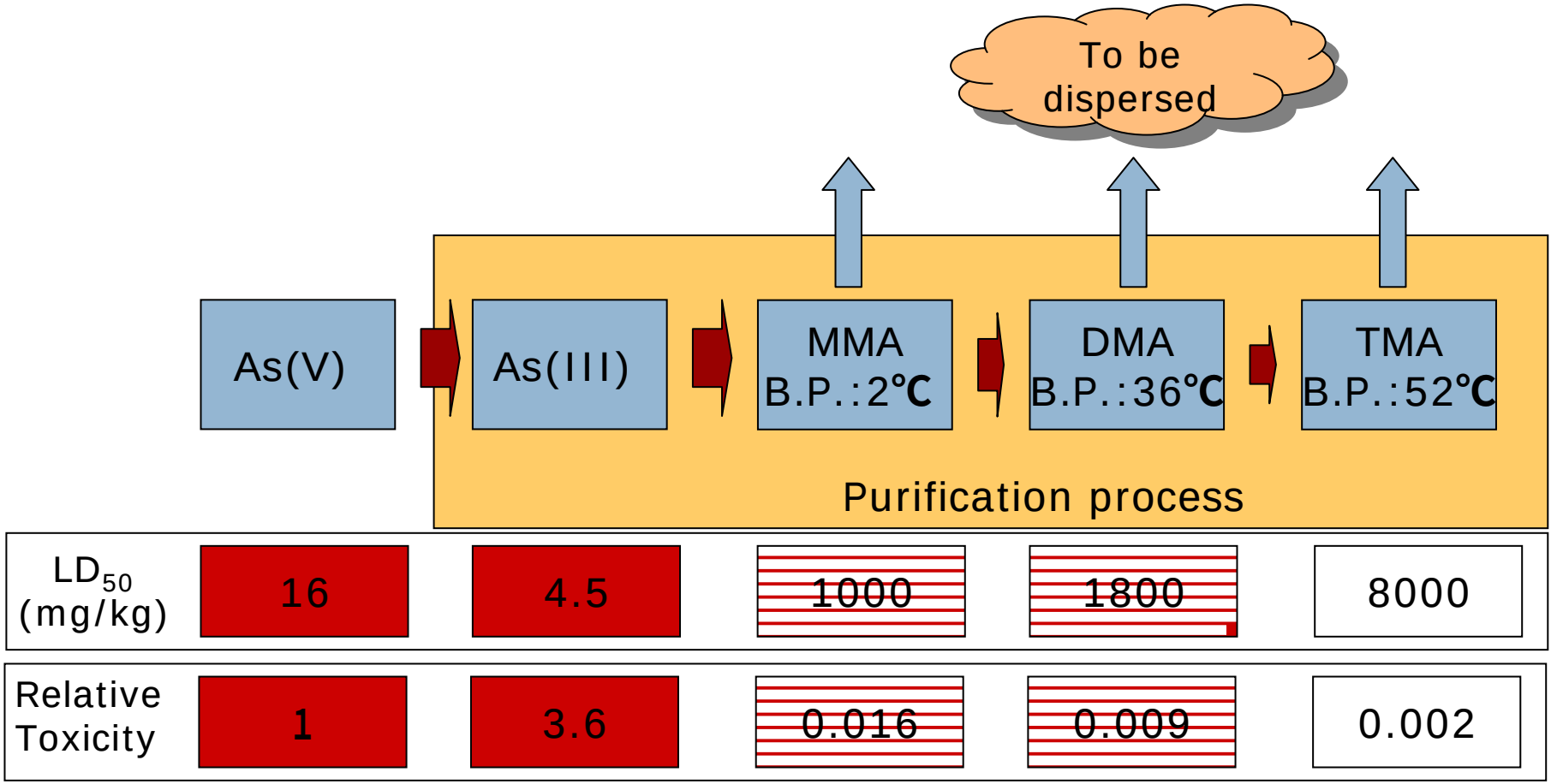
Arsenic removal technology

- Arsenic Iron Removal Plant: AIRP
  - Arsenic in groundwater is complexed with ferric hydroxide and removed with sand filter

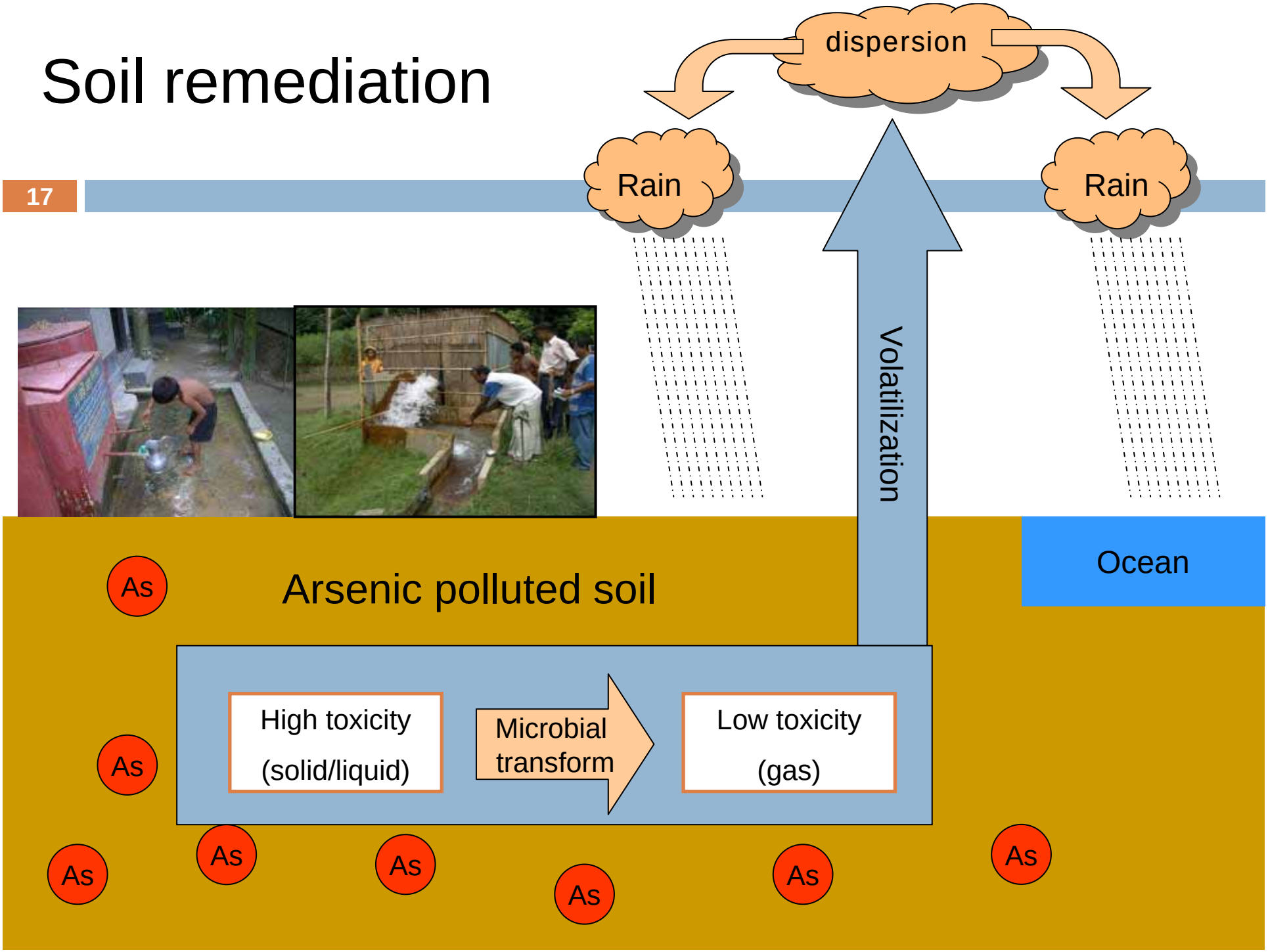


Need proper disposal → **As sludge**

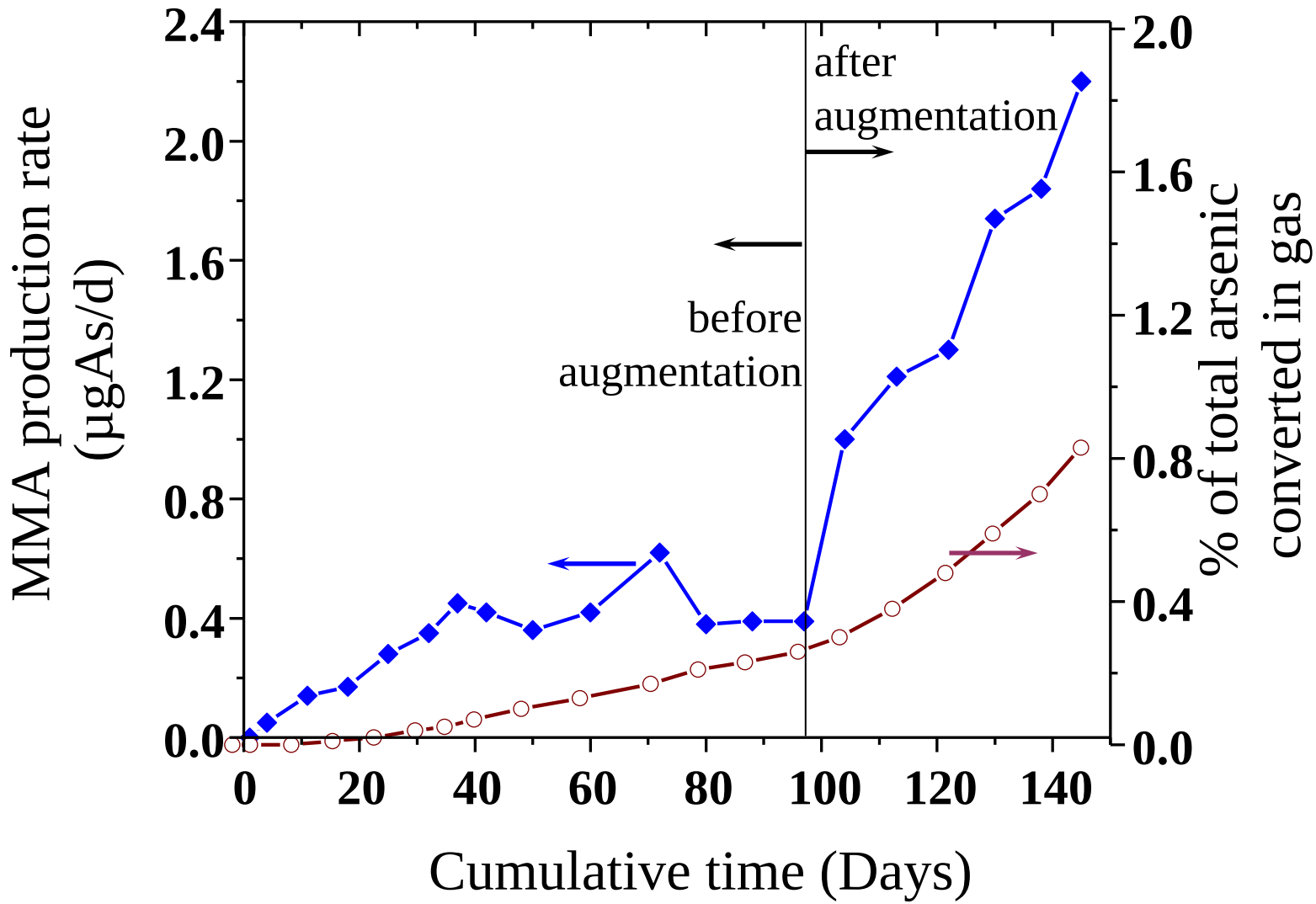
ARSENIC VOLATILIZATION



Soil remediation



Arsenic gasification rate in soil column

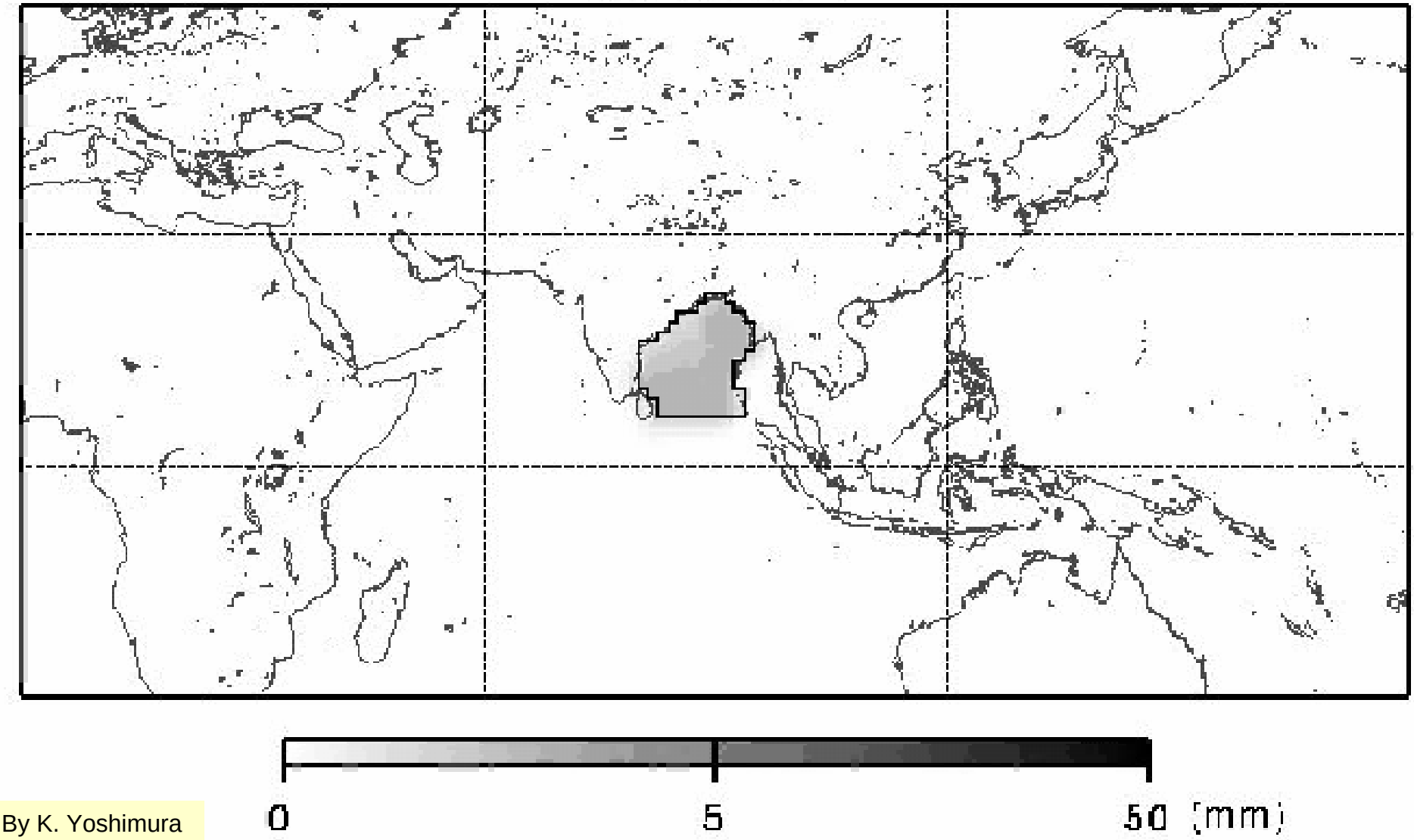


NATURAL EMISSION OF GASEOUS ARSENIC

- In order to promote arsenic methylation technology for environmental clean-up, we need to know natural arsenic emission level from earth.
- Natural emission of gaseous arsenic from earth is biologically conducted.
- Fate of gasified As should be investigated

Dist. of the moisture originated in Bengal Gulf

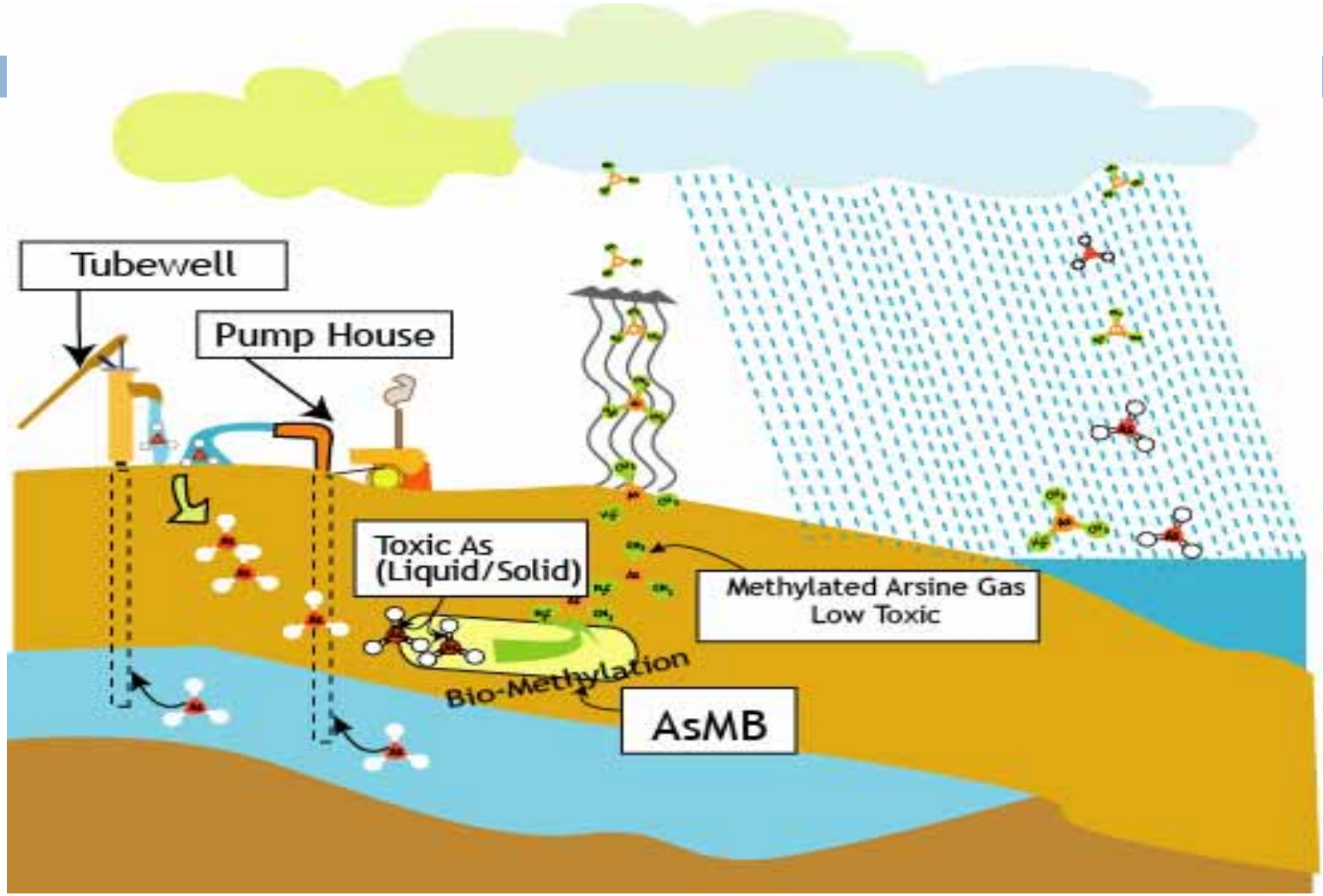
1998/04/01



By K. Yoshimura

Bengal_slow

Arsenic cycle on earth (conceptual)

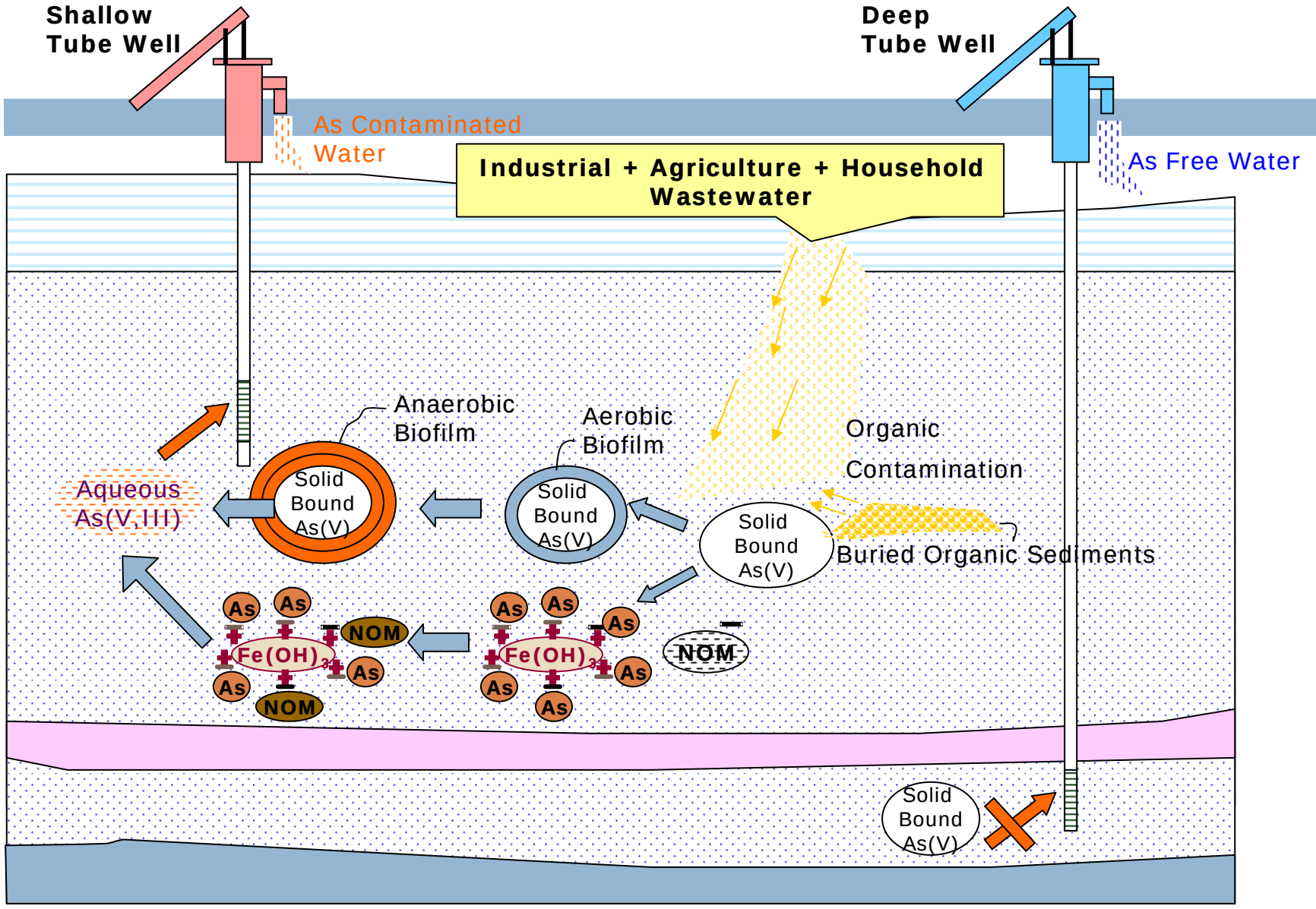


* As III/As V

* Methylated arsine (TMA)

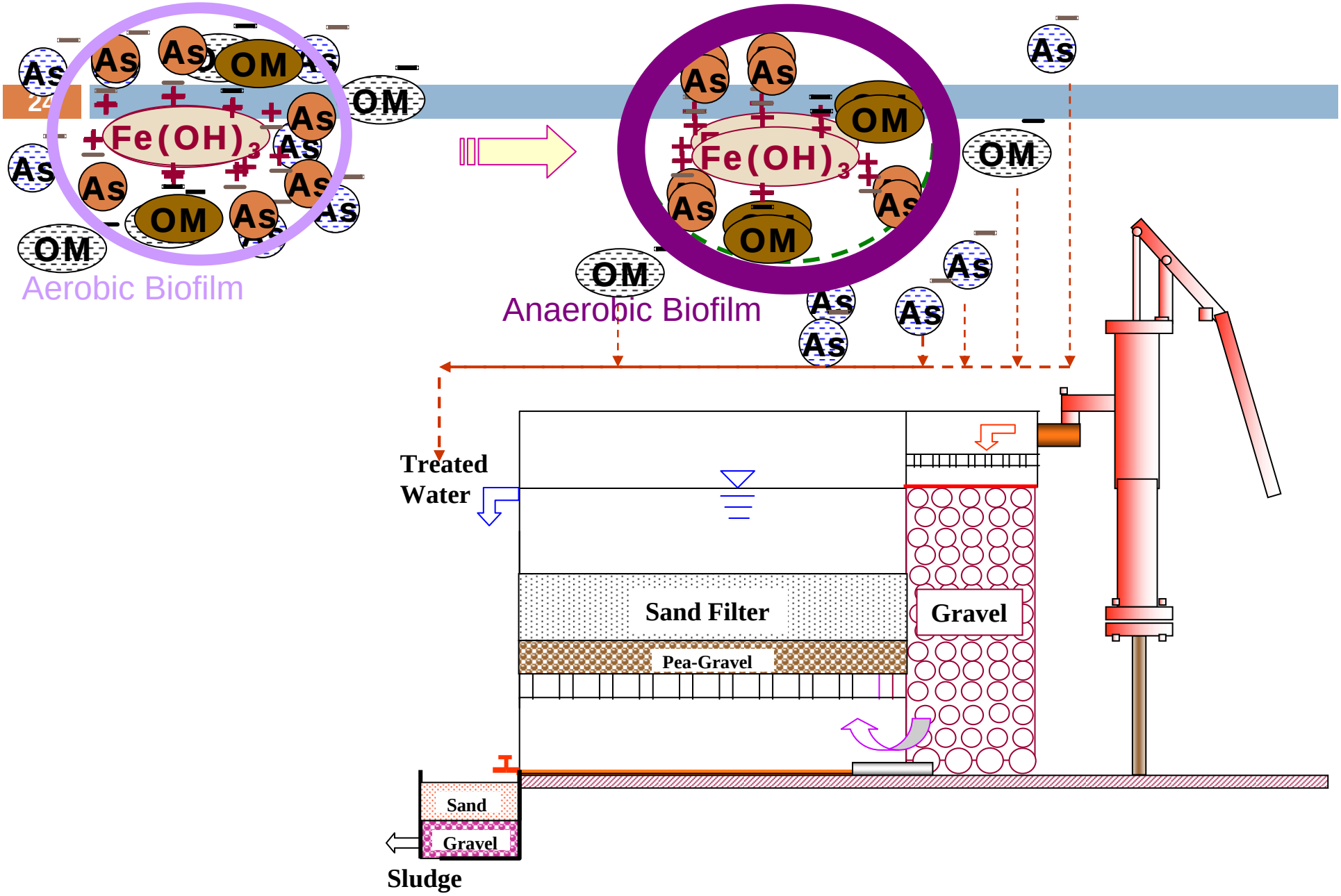
Biological liquefaction of arsenic

Conceptual Arsenic Leaching Mechanism in Groundwater in Response to Organic Matter



Arsenic Leaching: AIRP Perspective

Bioleaching of arsenic from the accumulated sludge in AIRP filter bed tion



Biotransformation of arsenic

- Gasification by arsenic methylating bacteira (AsMB)
- Liquefaction by anoxic organisms
- Other biological oxidation/deduction of arsenic

- Understanding of natural system of the country/region
- Strategy for the adaptation

Thanking you

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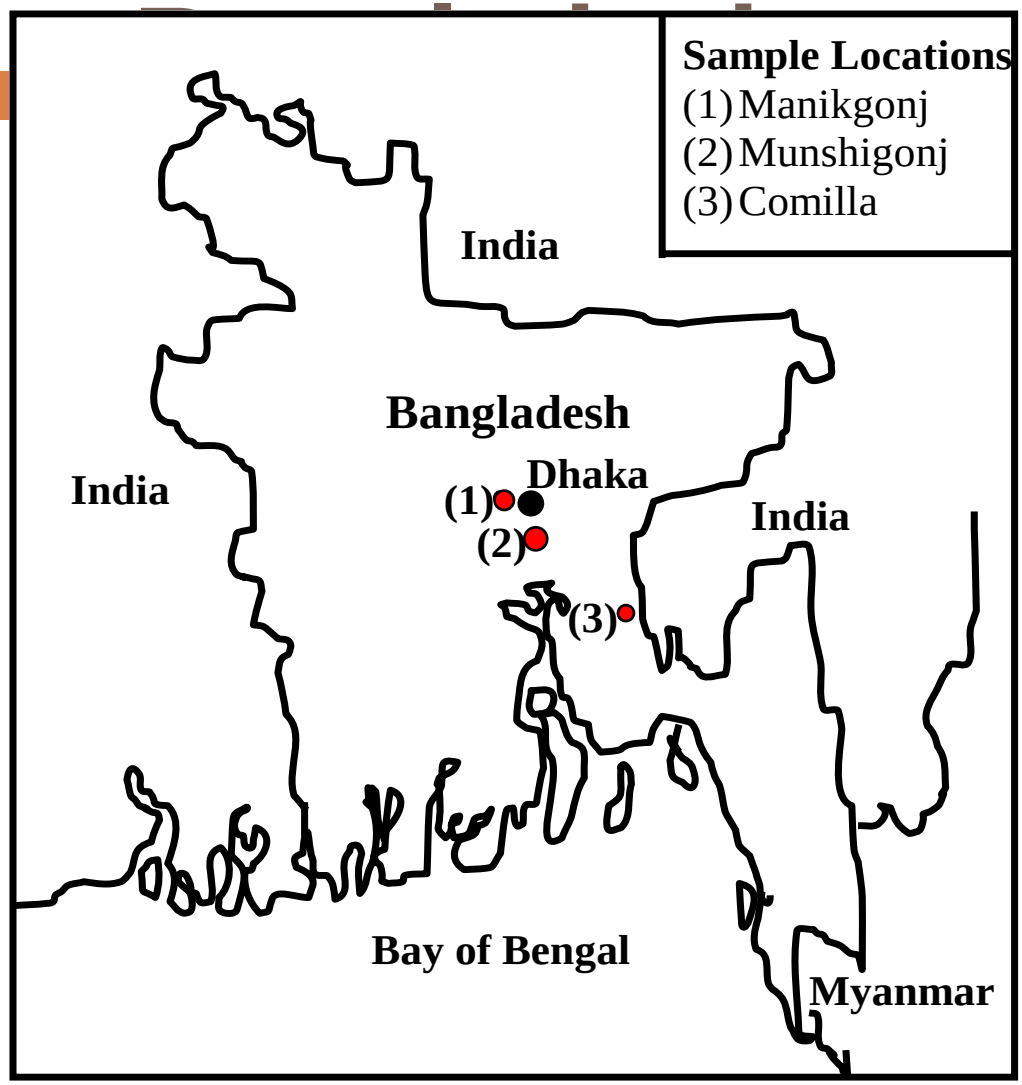
Bangladesh


Panchagarh
Thakurgaon
Nilphamari
Lalmonirhat
Kurigram
Dinajpur
Rangpur
Gaibandha
Joypurhat
Sherpur
Sunamganj
Sylhet
Netrakona
Noagaon
Jamalpur
Bogra
Mymensing
Nawabganj
Moulvibazar
Kishoreganj
Hobiganj
Rajshahi
Natore
Sirajganj
Tangail
Gazipur
Pabna
Narshingdi
Dhaka
Brahmanbaria
Kushtia
Manikgonj
Narayangathi
Mehor pur
Chua danga
Comilla
Jhenaidah
Magura
Faridpur
Munshiganj
Khagrachari
Chandpur
Madaripur
Sharsatpur
Narail
Gopalganj
Feni
Jessore
Lakshmipur
Noakhali
Rangamati
Barisal
Pirojpur
Satkhira
Khulna
Bagerhat
Jhalokathi
Chittagong
Patuakhali
Bhola
Barguna
Bandarban
Cox's Bazar
BAY OF BENGAL

Latest statistics on arsenic conc in groundwater of Bangladesh

Total area in Bangladesh (km^2)	**147,570**
Total population (million)	**128**
Total number of administrative districts	**64**
Total number of districts surveyed	**60**
Total number of districts where arsenic concentration exceeds 0.01 mg/l	**52/60**
Total number of districts where arsenic concentration exceeds 0.05 mg/l	**41/60**
Total area where arsenic concentration exceeds 0.05 mg/l (km^2)	**89,186 (60%)**
Total population where arsenic concentration exceeds 0.05 mg/l (million)	**85 (66%)**
Median value of arsenic concentration observed in tested samples (mg/l)	**0.0108**
Maximum arsenic concentration observed in tested samples (mg/l)	**1.67**

Arsenic concentration in agriculture soil in



Location	Arsenic concentration (mg/kg)
(3)	9.8±0.7
(3)	3.9±0.4
(3)	40.4±2.1
(2)	7.0±0.7
(2)	3.9±0.5
(2)	80.9±4.2
(1)	46.5±2.4
(1)	12.3±1.1
(1)	55.6±3.2
(1)	60.1±3.7

* Depth of soil 0-50 cm