

# Humanitarian Environmental Health Response in an Active Mercury Smelter Community Kyrgyzstan

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# TIFO Childhood Metals Poisoning Historical Perspective

- 50 years Past Bunker Hill Smelter Baghouse Fire - Kellogg, Idaho
- 40 Years Past Industry Abandons US - Superfund Commences
- 20 Years Past Childhood Lead Poisoning eliminated in Wealthy Countries  
Unprecedented Global Death and Disability
- 10 years Past TIFO Environmental Health Partnership with  
Doctors without Borders (Médecins Sans Frontières, MSF)

# MSF in Kyrgyzstan



**2005-2014:** MSF conducted projects to address drug resistant tuberculosis (TB)

**2012-2014:** MSF and Ministry of Health (MOH)

- assessed non-communicable diseases (NCD)
- found birth defects and reproductive health effects to be high in Batken Region

**2016-2023** MOH/MSF/TIFO Health Response





# Batken Region, Kyrgyzstan



- Part of the USSR until 1991
- 10-25% global Hg during Cold War
- By 2013, only active primary Hg smelter in the world
- Legacy environmental contamination





# Aidarkan, Kyrgyzstan

# Main Data Sources Reviewed

- Soviet Era Declassified Documents
- Kyrgyz Ministry of Health Report, 2000 (confidential)
- UNEP Trans-Boundary Security Investigations, 2005-2013
- **Minamata Convention Investigations, 2015-2018 (Confidential)**
- MSF Support Investigations with TIFO, 2016-2019

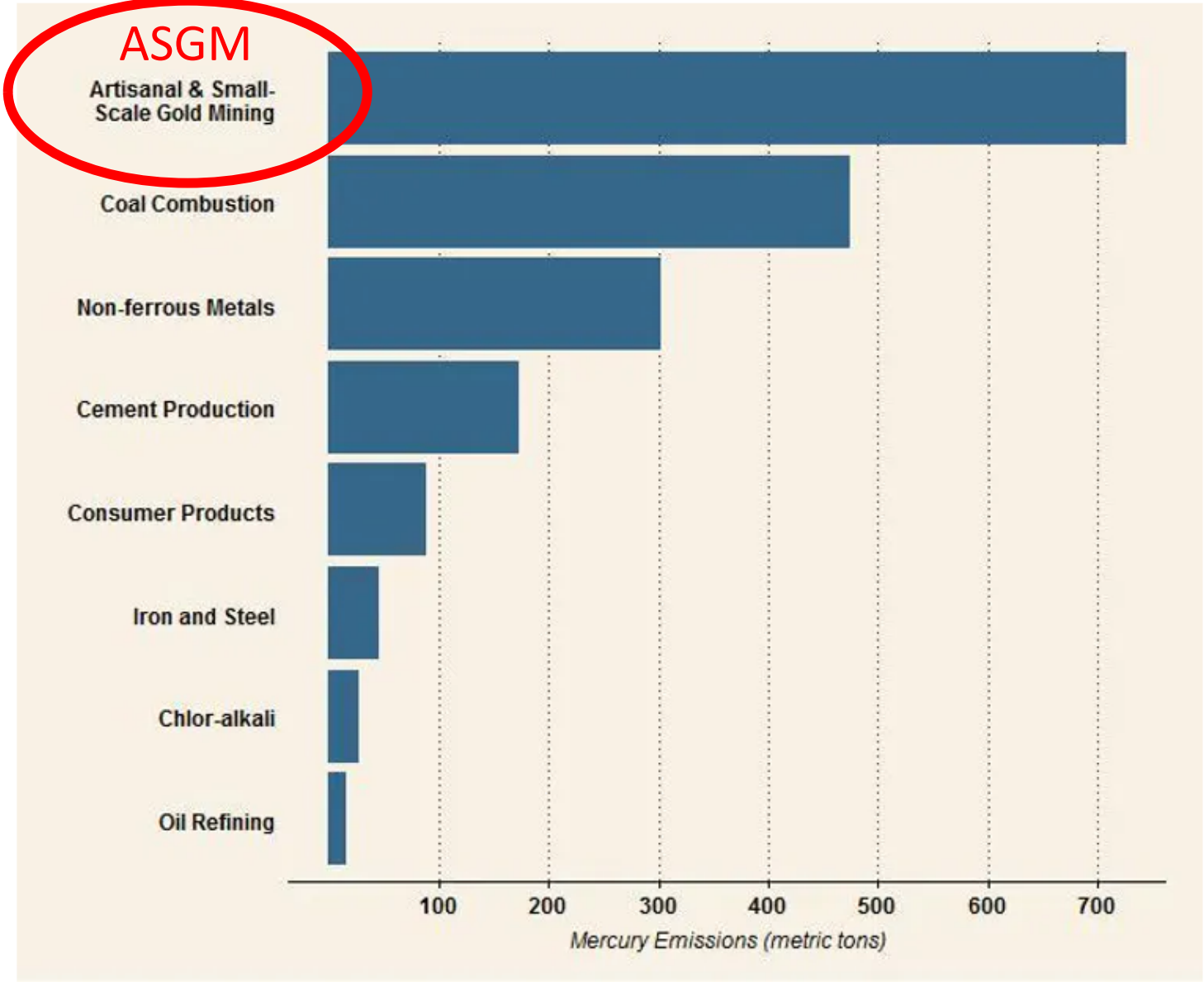
# Minamata studies: UN report “Aidarkan Mercury Mining Environment and Health Assessment Concept and scoping paper” (2013)

- **Protocols for sampling & biomonitoring (2015-16)**
- **Focus on active smelter**
- **Discussion on smelter closure led to UN being asked to leave Kyrgyzstan (2016)**

UNEP, 2013: Aidarkan Mercury Mining. Environment and Health Assessment. Concept and scoping paper. UNEP Chemicals Branch, Geneva, Switzerland



# Global Mercury



Mercury emissions from the eight highest emitting industry sectors. Data for 2010 from the 2013 UNEP Global Mercury Assessment. Total estimated global anthropogenic mercury emissions are 1960 metric tons. USEPA



# Human Health Risk Assessment (HHRA)

- Identify Exposure Pathways, High Risk Populations, and Mitigation Strategies that could be Implemented for Residential Exposures
- Focus on women and children
- Address three metals Hg, Sb and As
- Assess oral food, water, soil, dust exposures (NOT AIR!)
- Avoid smelter and mine properties and occupational exposures!
- Initially did not consider cancer risk!

Limitations  
imposed by Kyrgyz  
gov't

# Chauvay, Kyrgyzstan





# Stibnite Arsenopyrite Mine Haul Road



# Elementary School Children School Crossing





# School District Minivan





## Relative Bioavailability (RBA) – How much Arsenic absorbed in bloodstream

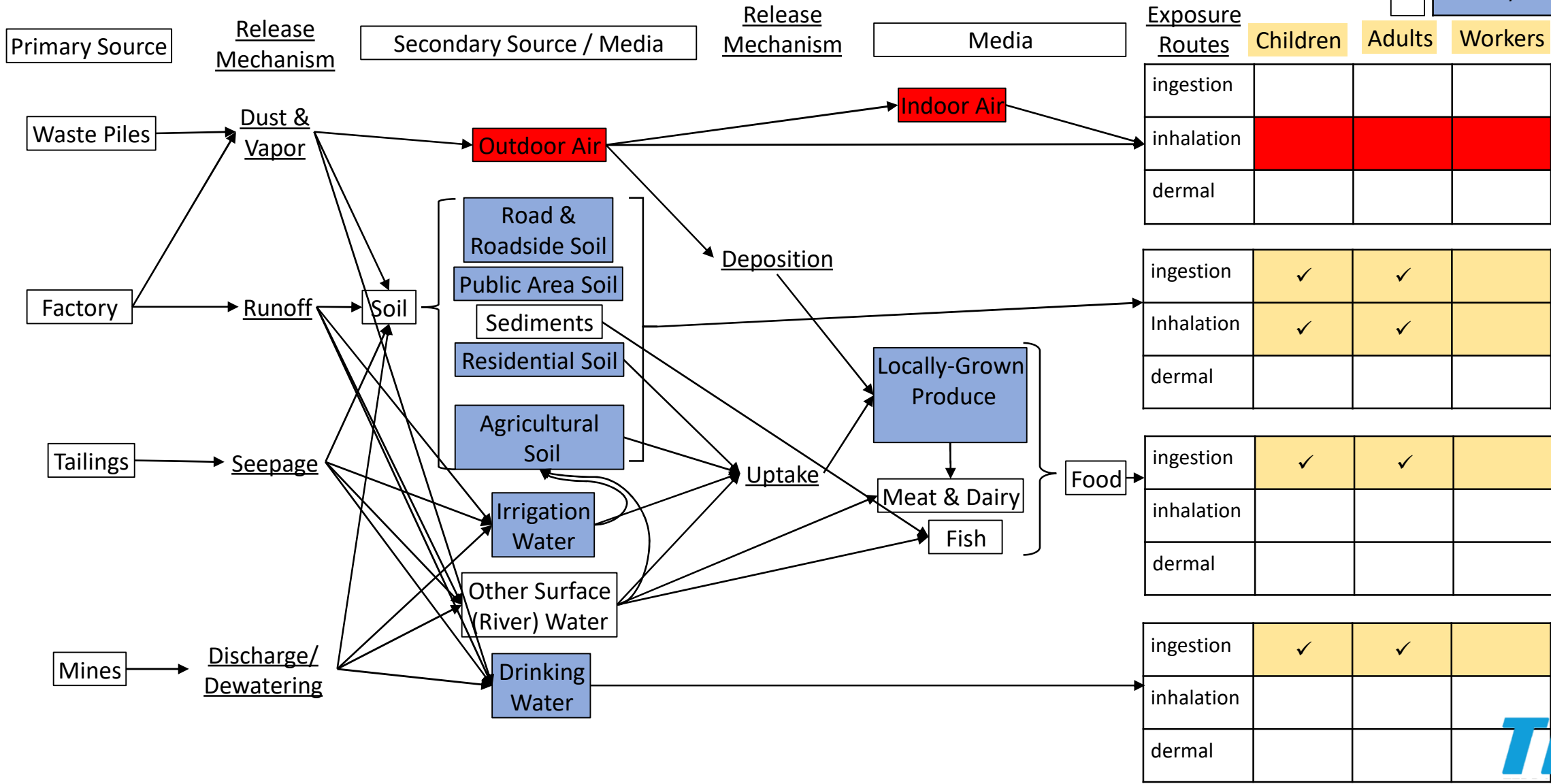
EPA fed 29 different US arsenic contaminated wastes to swine observed the *in vivo* RBA ranging from less than 10% to more than 60%.

### RBA for Haul Road Dusts in Central Asian Antimony/Arseno-pyrite Mining Operation

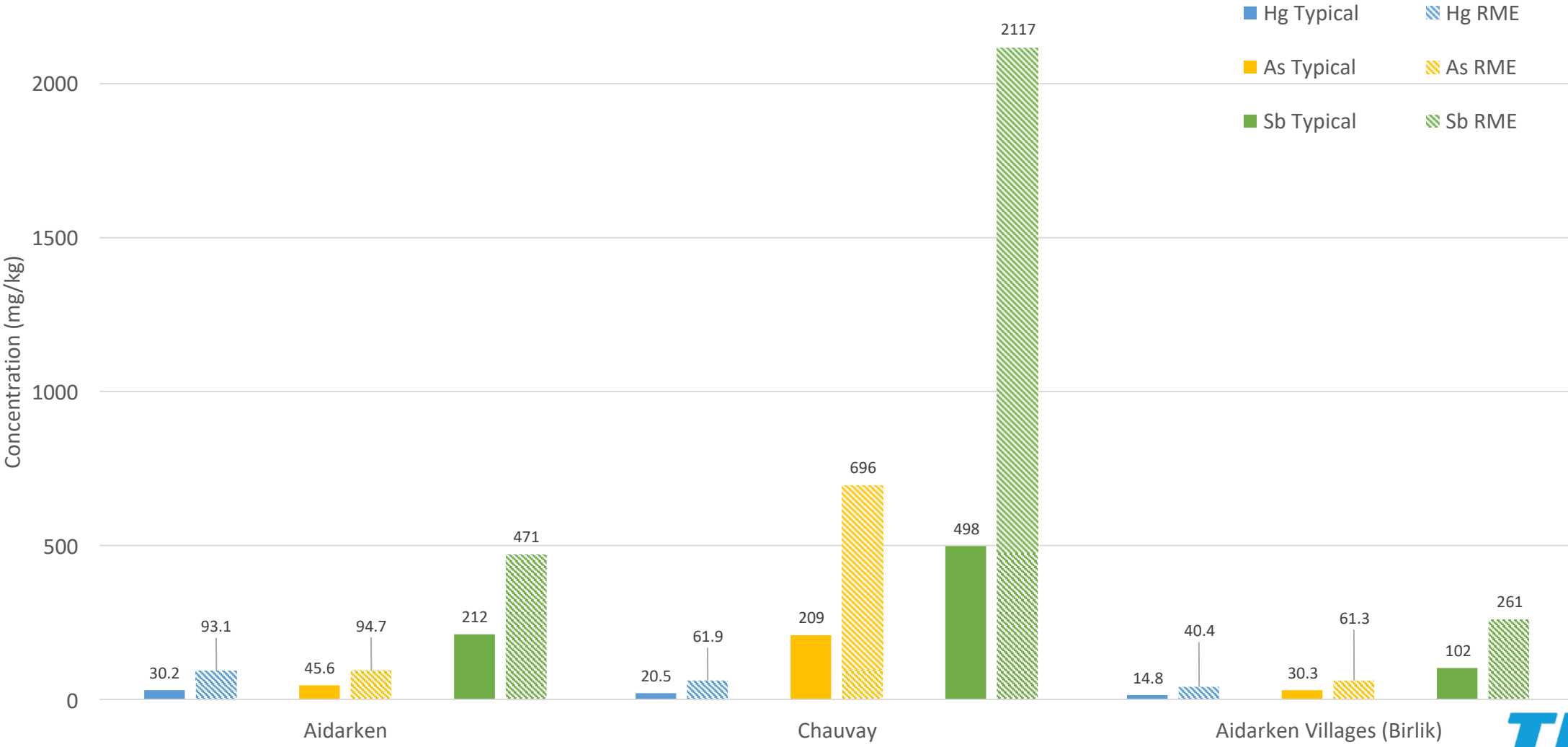
		Total Arsenic (mg/kg)	As RBA (%)
<b>Haul Road/Waste</b>	N	4	4
	Minimum	521	50%
	Maximum	2652	70%
	Average	1691	63%
<b>Sediment in Adjacent Stream</b>	N	6	5
	Minimum	52	27%
	Maximum	293	62%
	Average	140	49%

# Exposure Assessment

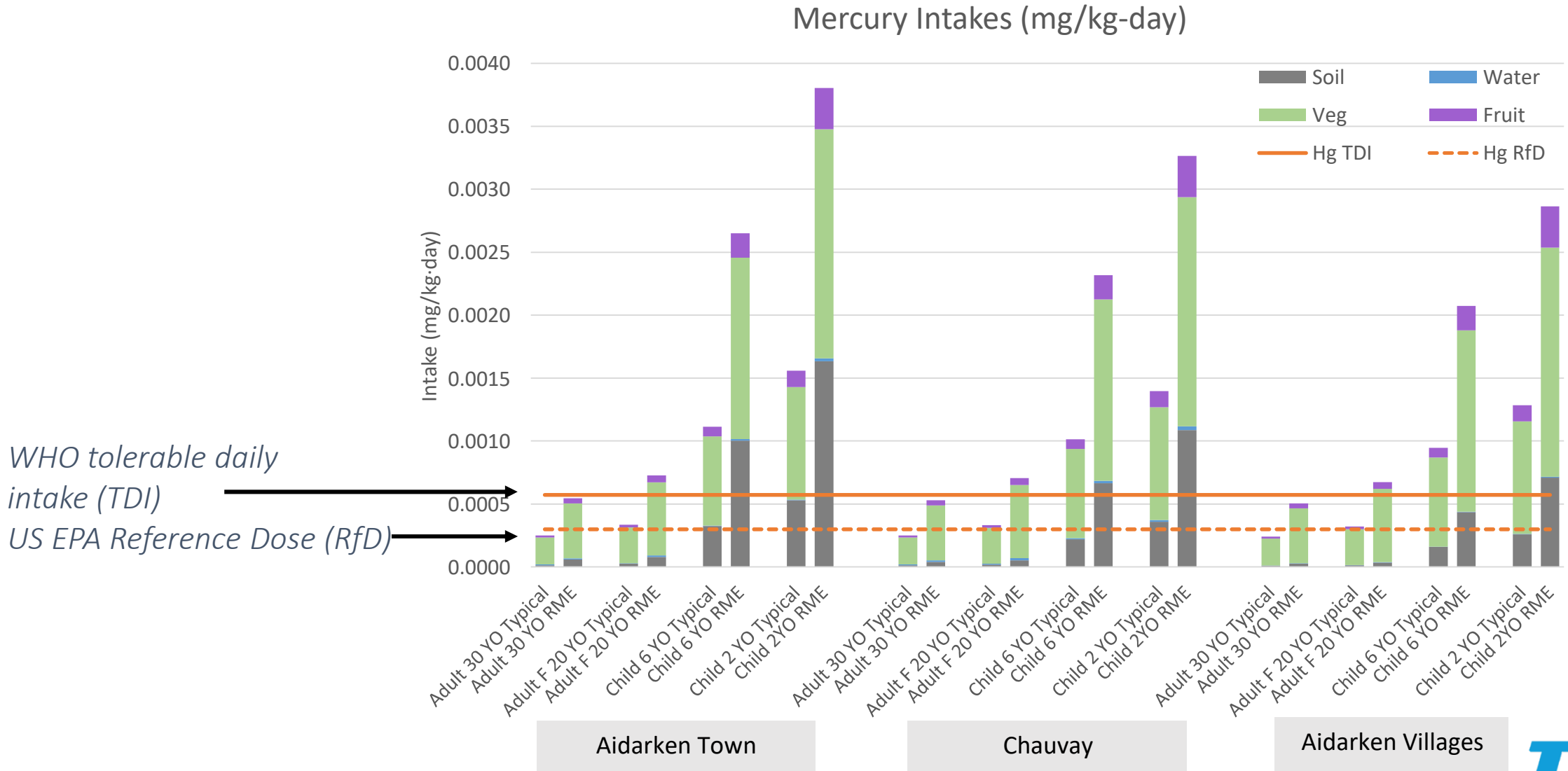
Legend	Complete Pathway	✓
	Incomplete Pathway	✓
	Unknown	✓
	Primary Data Needs	



# Soil Concentrations (mg/kg) in 3 Areas (Typical & Reasonable Max Exposure (RME))



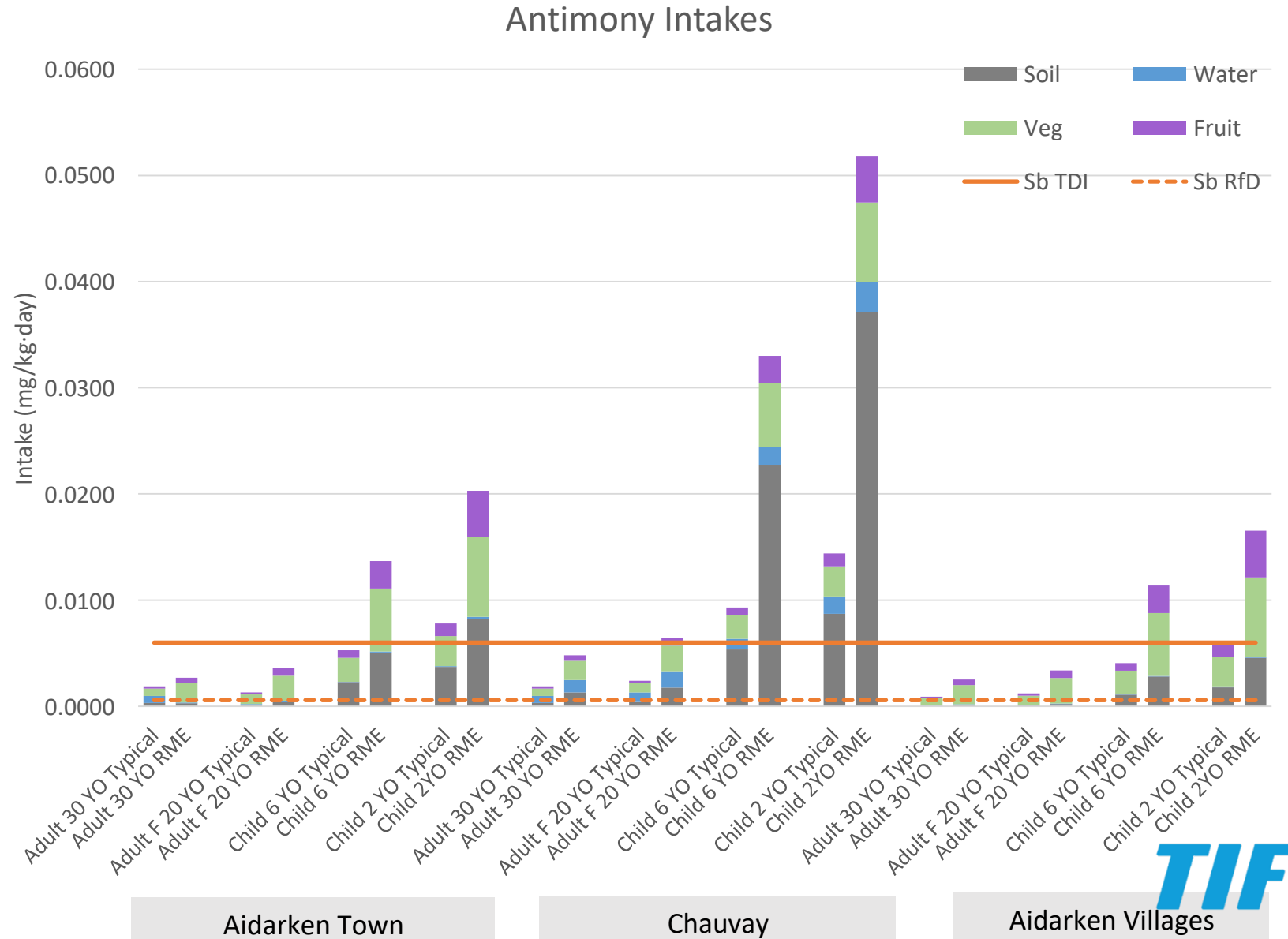
# Mercury Intakes in 3 Areas (Typical & Reasonable Max Exposure (RME))





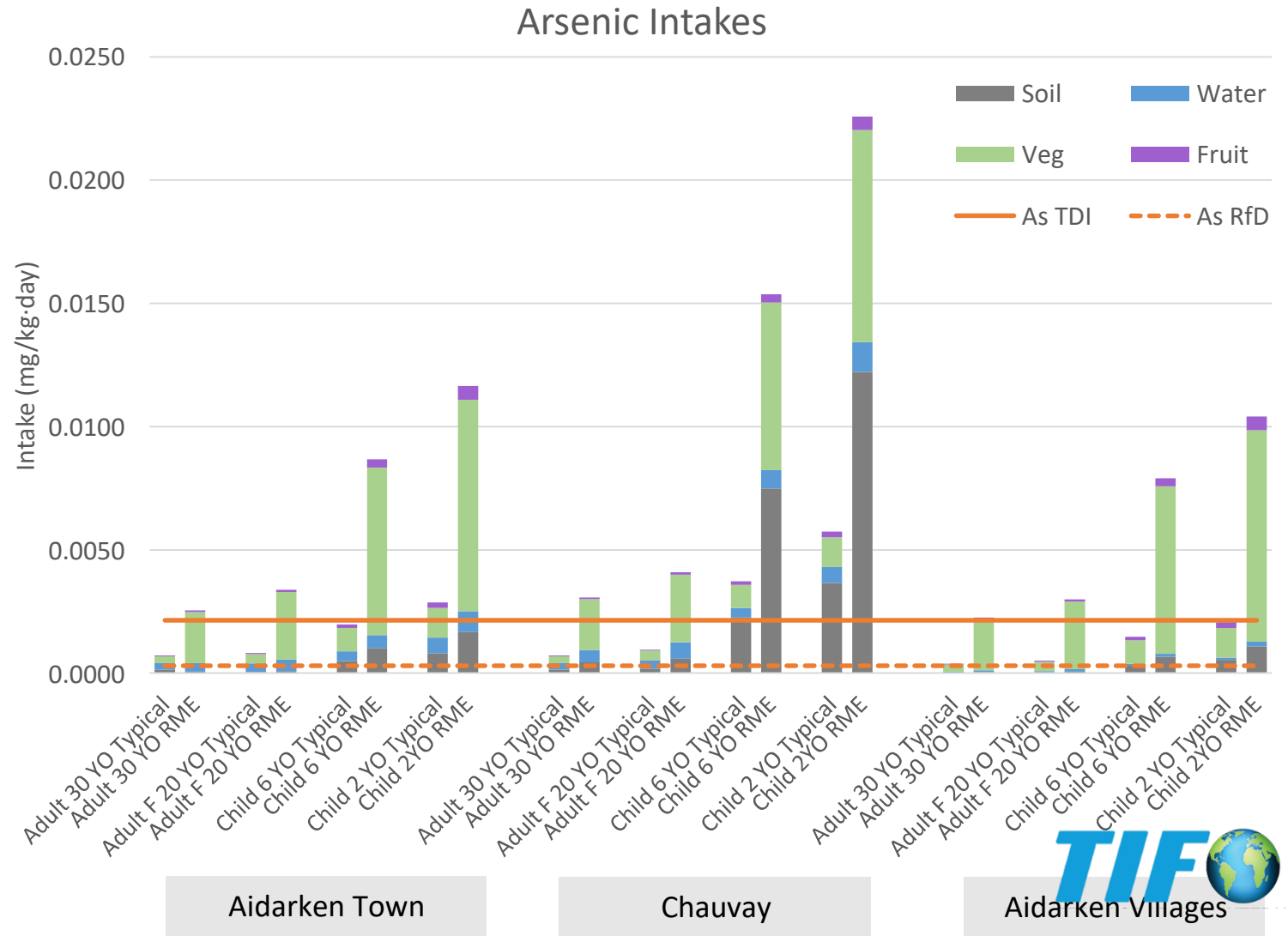
# Antimony Intakes

Figure 8. Antimony intakes (in mg Sb per kg body weight per day) for the three areas, by risk group and exposure scenario (typical and reasonable maximum exposure (RME)). The WHO tolerable daily intake (TDI) and the US EPA Reference Dose (RfD) are indicated by solid and dashed orange lines, respectively.



# Contaminant Intakes (Figures 5-9)

Figure 5. Arsenic intakes (in mg As per kg body weight per day) for the three areas, by risk group and exposure scenario (typical and reasonable maximum exposure (RME)). The WHO tolerable daily intake (TDI) and the US EPA Reference Dose (RfD) are indicated by solid and dashed orange lines, respectively.



# Summary of Non-cancer Hazard Indices (all metals).

Levels 1 and 2 indicate low risk. Level 3 indicates need to further investigate to determine whether exposure mitigation efforts are appropriate. Levels 4 and 5 indicate that the populations should be made aware of the excessive risk and measures to reduce risk should be identified and implemented where appropriate.

		Negligible Concern (Level 1)	Minimal Concern (Level 2)	Some Concern (Level 3)	Concern (Level 4)	Serious Concern (Level 5)	Total
Aidarken	30-year-old	40%	50%	10%	.	.	100%
	20-year-old female	35%	55%	10%	.	.	100%
	6-year-old	.	25%	30%	35%	10%	100%
	2-year-old	.	15%	20%	45%	20%	100%
Chauvay	30-year-old	35%	50%	15%	.	.	100%
	20-year-old female	25%	60%	15%	.	.	100%
	6-year-old	.	15%	25%	35%	25%	100%
	2-year-old	.	10%	15%	35%	40%	100%
Aidarken Villages	30-year-old	50%	40%	10%	.	.	100%
	20-year-old female	45%	45%	10%	.	.	100%
	6-year-old	.	40%	25%	25%	10%	100%
	2-year-old	.	30%	25%	30%	15%	100%

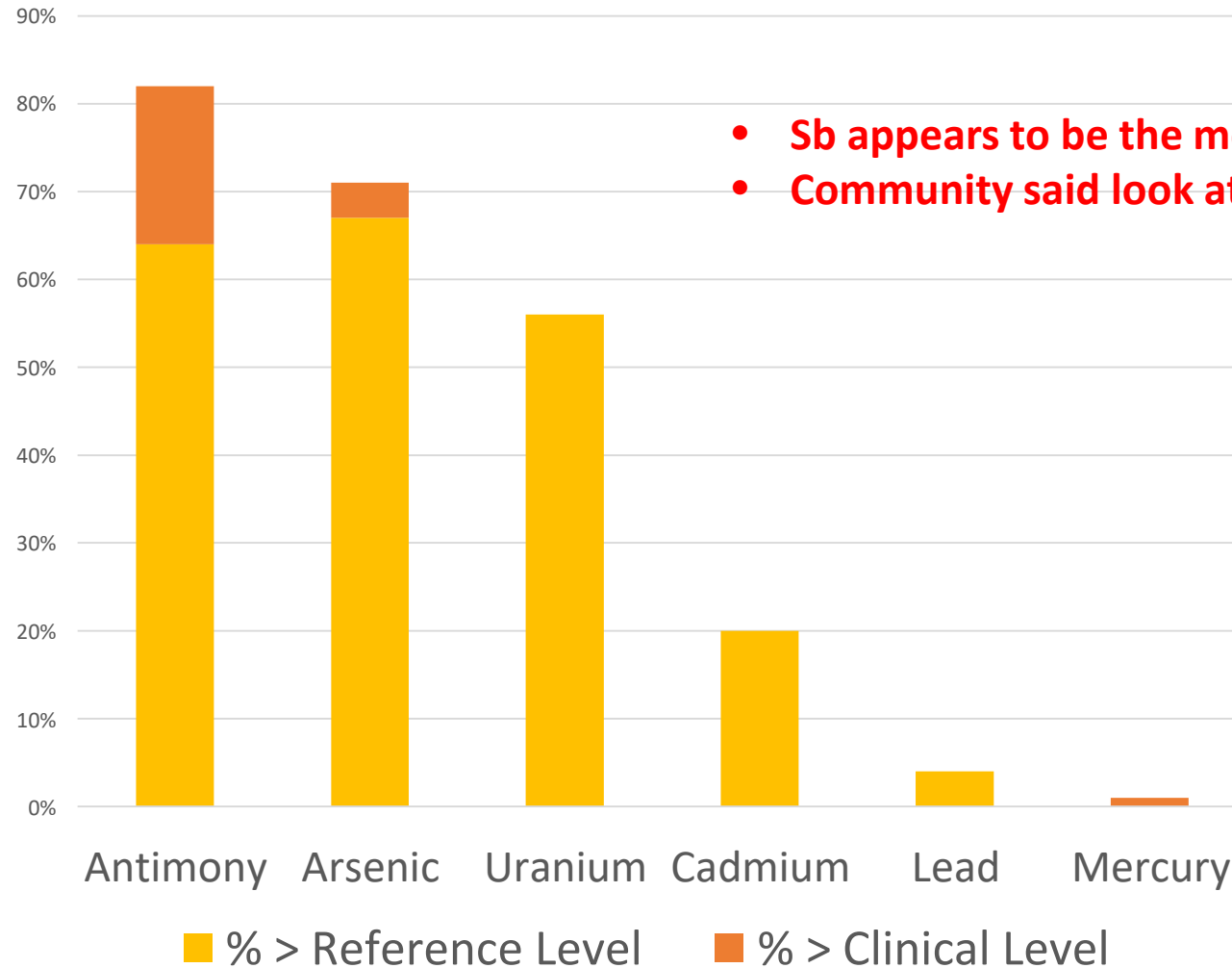


# Biomonitoring Study

- Conducted in high-risk areas of Chauvay, Eshme and Aidarken
- 235 Participants were selected at random among 5-14 y.o. children and 15-49 y.o. females living near known environmental hazards
  - Selected due to their higher vulnerability to heavy metal exposure.
- Blood and urine specimens were collected from selected participants, respecting standard procedures.

# Biomonitoring Results

% of 235 Participants above Reference Levels and Clinical Action Levels



- Sb appears to be the most significant hazard
- Community said look at cancer risks too

# 2022 Update: Lifetime Oral Arsenic Cancer Risk

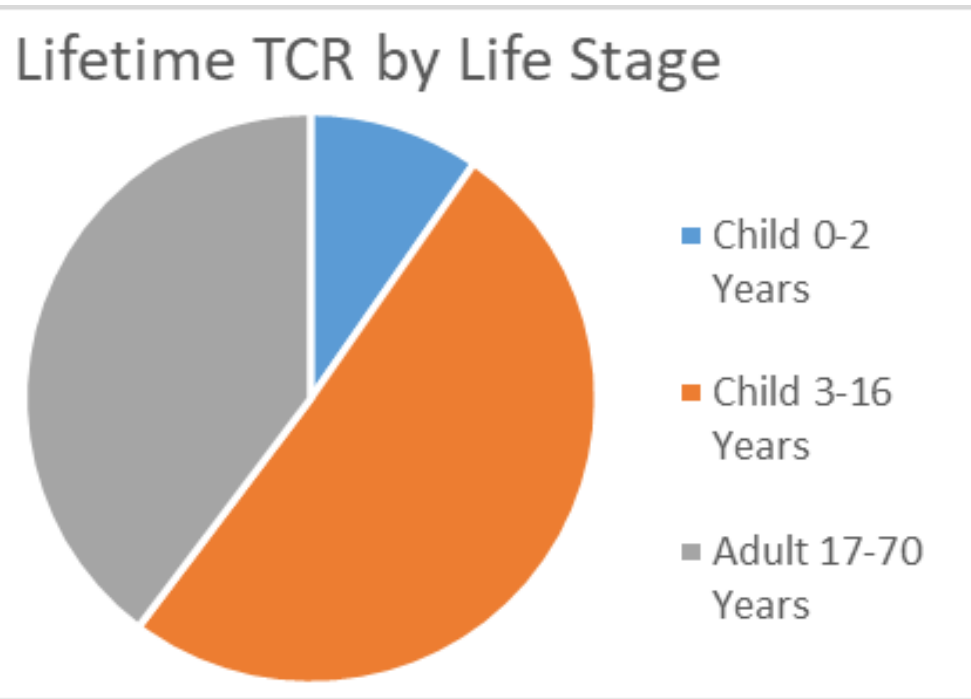
- Lifetime CR for Typical and RME scenarios for each community.
- Total CR: from  $10^{-3}$  in the Villages Typical Scenario to  $10^{-2}$  in Chauvay RME scenario
- All communities exceed the recommended US health criteria of  $10^{-4}$  to  $10^{-7}$  (1 in 10,000 to 1 in 10,000,000) range of probability of excess *cancers from oral exposure alone*.

Exposure Source	Aidarken		Chauvay		Aidarken Villages	
	Typical	RME	Typical	RME	Typical	RME
Soil	2.1E-04	4.4E-04	9.8E-04	3.3E-03	1.4E-04	2.9E-04
Water	6.3E-04	8.3E-04	6.4E-04	1.2E-03	9.2E-05	1.9E-04
Veg Food	7.5E-04	5.4E-03	7.5E-04	5.4E-03	7.5E-04	5.4E-03
Fruit Food	6.1E-05	1.4E-04	6.1E-05	1.4E-04	6.1E-05	1.4E-04
Total	1.7E-03	6.8E-03	2.4E-03	1.0E-02	1.0E-03	6.0E-03

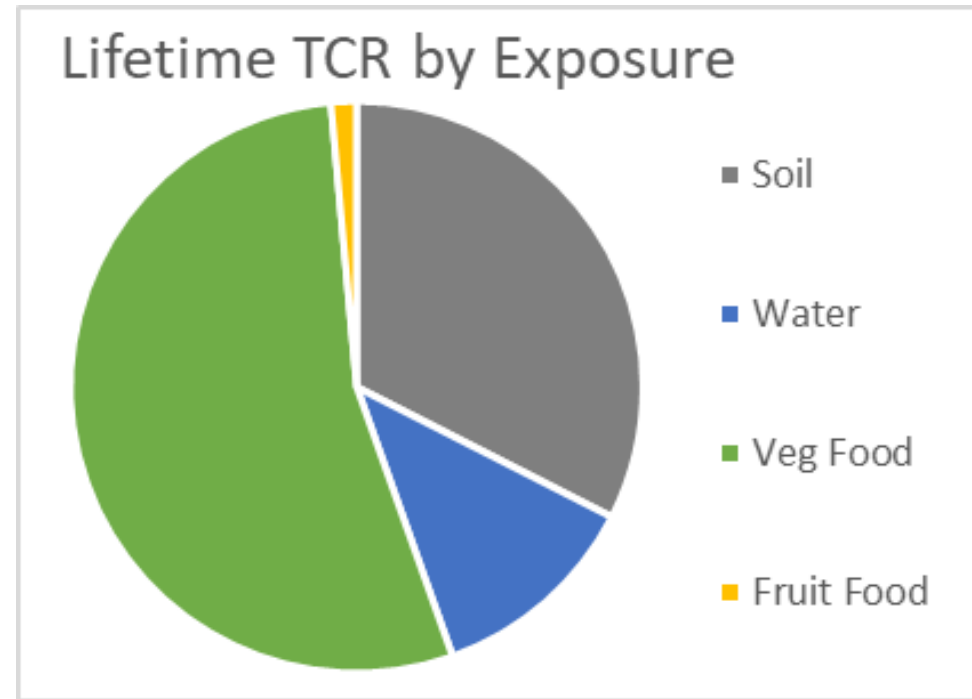


# 2022 Update: Oral Arsenic Cancer Risk

Contribution of exposure during each life stage to lifetime total cancer risk (TCR) in Chauvay RME scenario.



Contribution to lifetime total cancer risk (TCR) for different environmental media in Chauvay RME Scenario.



**Conclusion: Biggest Cancer Risk is to Children under 16 yrs. from Vegetables / Soil**

# MSF Principles

- Don't diagnose if you can't treat
- If you diagnose, you must treat

## Health Response Interventions

- Followup Notification and Counseling
- Health Promotion Activities
- Medical Treatment
- Public Health Advocacy
- Pilot Remediation (Water Supply and Schools)
- Solicit for Assistance

# Medical Treatment Antimony Dilemma!

- No other community population has demonstrated this level of absorption
- Little is known about Sb toxicity, especially for chronic oral exposures
- Most data from
  - worker inhalation exposures
  - ONE animal study on rats in 1979 (RfD based on this injection study)
- Symptoms of acute exposures:
  - Lung and eye irritation
  - Heart muscle damage
  - Vomiting
  - Stomach ulcers
  - Abdominal pain
- Cardiovascular toxicity?
- Possible Human Carcinogen (Inhalation)

# Example of Health Promotion Materials

AVOID



PRACTICE





# Pilot Remediation



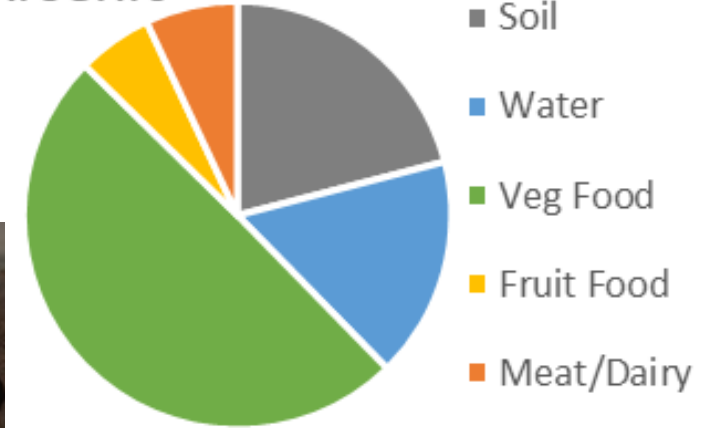


# Next steps

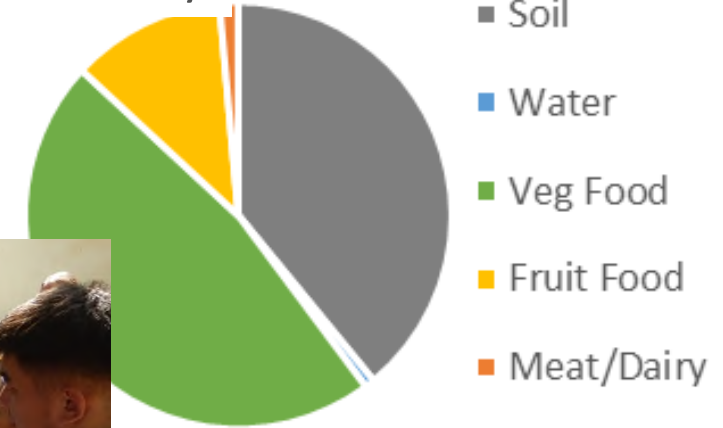
- Communicating Results
- Public Health Intervention Program
  - Health messaging on exposure reduction
  - Physician training
  - Small-scale remediation
- Laboratory Capacity Building
  - Provision of equipment for heavy metal analyses in food, water, soil
  - Development of program for local residents to have food tested
- Advocating for additional work by government and NGOs in region



Arsenic



Antimony



# Accomplishments

- Completed UN Minamata risk and health assessment with community engagement. Added high risk mining area of Chauvay.
- Identified previous unknown mining related risks, including unprecedented Sb absorption
- Secured community and government cooperation to implement remedies
- Secured cooperation to get outside money to do more

# Stibnite Idaho - Kyrgyz Parallels

- WWII History
- Remote Mountain Communities
- Similar High Arsenic Antimony Ores
- Carlin Gold Recovery Revival
- Haul Roads and Arsenic Emissions
- Economically Dependent Communities
- Mining Friendly Political Jurisdictions
- Intimidated Regulators
- Effective Public Relations Campaigns
- Public Relations vs. Regulatory Submittals Dichotomy
- Strategic Metals Security Justifications
- Unknown Antimony Toxicity and Bioavailability
- No Total Arsenic Risk Assessment



# Almost Last Words

- Aidarken Citizens are a Vulnerable Population
- Geo-political Reality demands Accommodation of Risky Practices
- The Wealthy United States can Implement Responsible Mining
- US Mining Operations should be held to the Highest Standards that reflect the True and Complete costs of Mineral Refining
- US Should not Import Metals from Irresponsible Operations
- US Consumers should pay the true cost of Mineral Exploitation
- States should not develop Havens for Exploitative Practices



# Last Words

Will we do better in developing GREEN ENERGY MINERALS?

What are the lessons from:  
COAL (black lung)  
PETROLEUM (benzene, tetraethyl Lead in gas)



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Rakhmat Saga

Thank You

# Summary of Non-cancer Hazard Indices (all metals).

Conclusion: hazard is highest for children in Chauvay due to soil and vegetables

*Hazard Indices across metals for all media, based on the WHO Tolerable Daily Intake (TDI) health-based criteria.*

		Typical					RME				
		Soil HI	Veg HI	Fruit HI	Water HI	Total HI	Soil HI	Veg HI	Fruit HI	Water HI	Total HI
Scenario 1, Aidarken, Typical EF	Adult Age 30 Years	0.1	0.6	0.1	0.1	0.9	0.2	2.1	0.2	0.2	2.7
	Adult F. Age 20 Years	0.1	0.8	0.1	0.2	1.2	0.2	2.8	0.3	0.3	3.6
	Child Age 6 Years	1.2	2.1	0.3	0.2	3.8	3.1	6.9	1.0	0.3	11.2
	Child Age 2 Years	1.9	2.6	0.6	0.3	5.4	5.0	8.7	1.6	0.5	15.9
Scenario 1, Chauvay, Typical EF	Adult Age 30 Years	0.1	0.6	0.1	0.2	1.1	0.5	2.1	0.2	0.5	3.2
	Adult F. Age 20 Years	0.2	0.8	0.1	0.3	1.4	0.7	2.8	0.3	0.6	4.3
	Child Age 6 Years	2.3	2.1	0.3	0.4	5.1	8.5	6.9	1.0	0.7	17.0
	Child Age 2 Years	3.8	2.6	0.6	0.6	7.6	13.8	8.7	1.6	1.1	25.3
Scenario 1, Aidarken Villages, Typical EF	Adult Age 30 Years	0.0	0.6	0.1	0.0	0.8	0.1	2.1	0.2	0.0	2.4
	Adult F. Age 20 Years	0.0	0.8	0.1	0.0	1.0	0.1	2.8	0.3	0.1	3.2
	Child Age 6 Years	0.6	2.1	0.3	0.0	3.0	1.5	6.9	1.0	0.1	9.5
	Child Age 2 Years	1.0	2.6	0.6	0.1	4.2	2.5	8.7	1.6	0.1	13.0