



กรมอนามัย
ส่งเสริมให้คนไทยสุขภาพดี

“การประเมินความเสี่ยงผลกระทบต่อสุขภาพ” Health Risk Assessment: Case Study

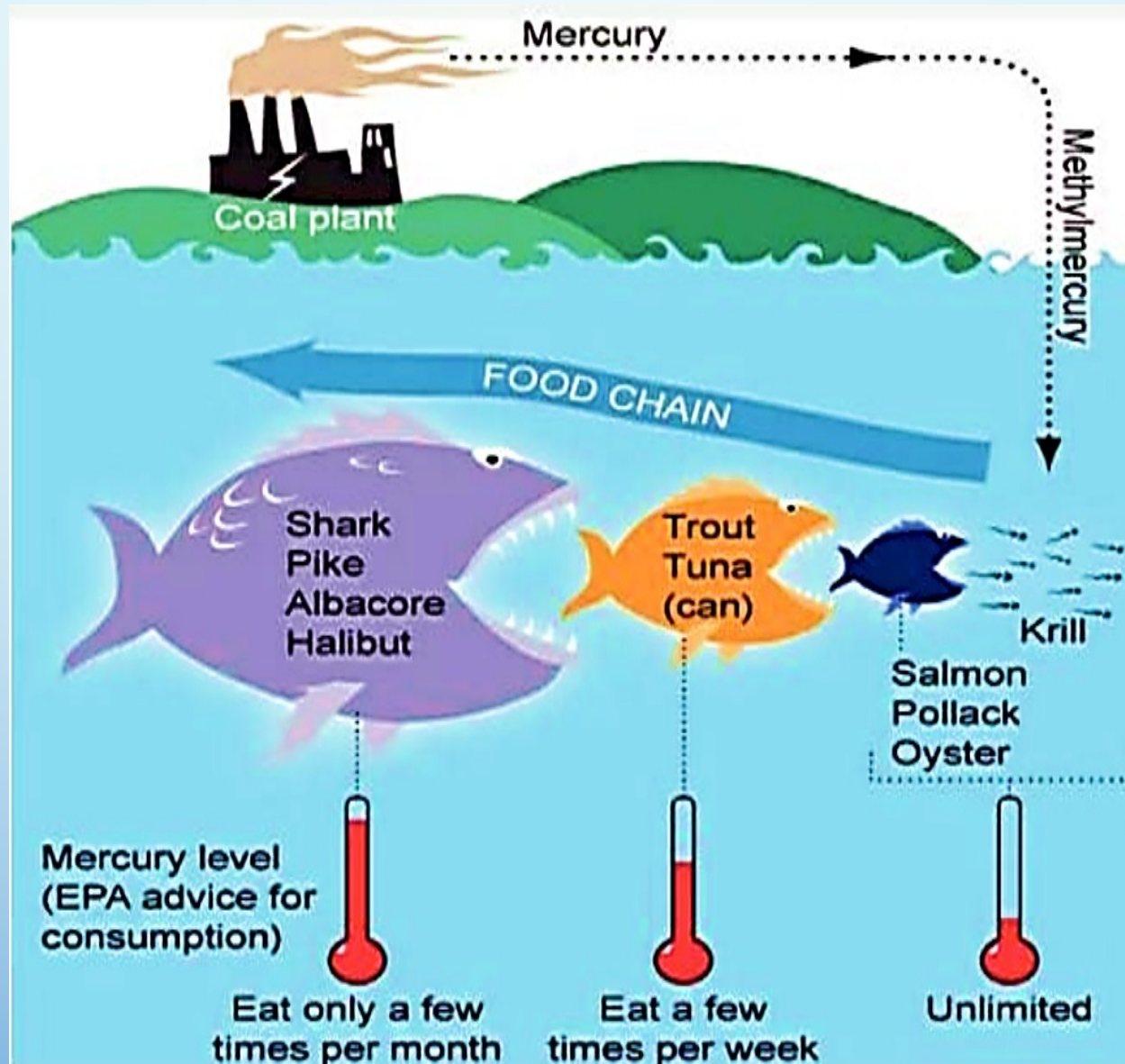
ผศ.ดร.ปกเกศ วงศาสุลักษณ์
วิทยาลัยวิทยาศาสตร์สาธารณสุข จุฬาลงกรณ์มหาวิทยาลัย

ENVIRONMENTAL MEDIA

- Air
- Water: surface/groundwater
- Soil



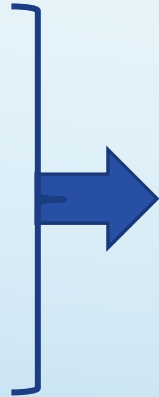
FOOD CHAIN



Exposure Routes

3 Main Routes of Exposure

- **Inhalation**
- **Dermal**
- **Oral Ingestion**



Acute / Chronic effects

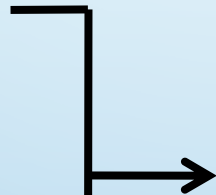


Health Risk Assessment: Quantitative

There are 4 Steps of Risk Assessment

Personal Information
(collect data or
references)

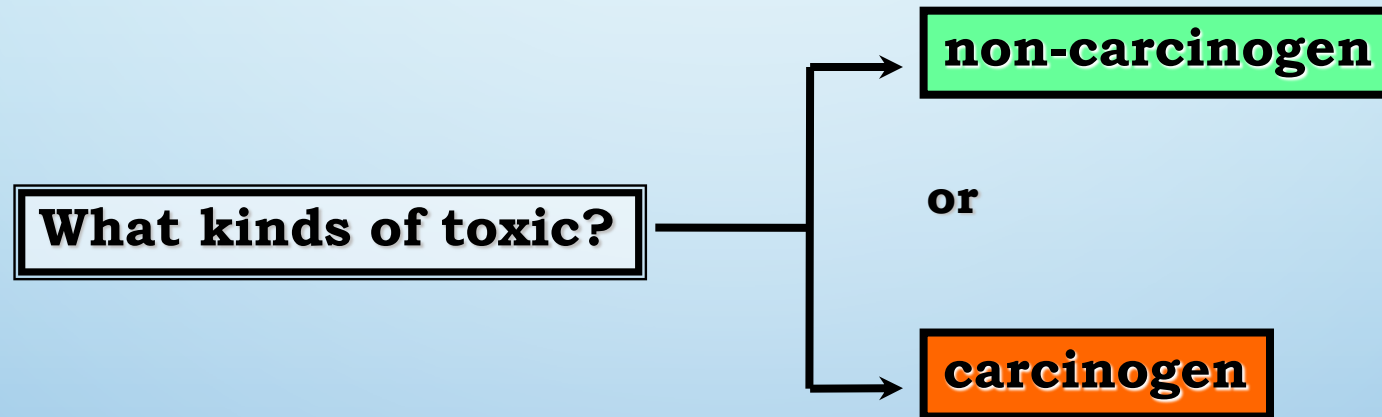
**Toxic (concentration
from lab analysis)**



- 1 Hazard identification**
- 2 Dose-response Assessment**
- 3 Exposure Assessment**
- 4 Risk Characterization**

Human Health Risk Assessment

Step 1 Hazard Identification



Human Health Risk Assessment

Step 2 Dose-Response Assessment



The screenshot shows the Integrated Risk Information System (IRIS) website. The browser window title is "Integrated Risk Information System (IRIS) | US EPA - Windows Internet Explorer". The address bar shows "http://www.epa.gov/iris/". The page header includes the U.S. Environmental Protection Agency logo and the text "U.S. ENVIRONMENTAL PROTECTION AGENCY". The main heading is "Integrated Risk Information System (IRIS)". Below this, there is a search bar with "Search: All EPA IRIS" and a "Go" button. A breadcrumb trail reads: "You are here: EPA Home » Research & Development » NCEA » Integrated Risk Information System (IRIS)".

The main content area describes the IRIS program: "The Integrated Risk Information System (IRIS) is a human health assessment program that evaluates quantitative and qualitative risk information on effects that may result from exposure to environmental contaminants. IRIS was initially developed for EPA staff in response to a growing demand for consistent information on substances for use in risk assessments, decision-making, and regulatory activities. The information in IRIS is intended for those without extensive training in toxicology, but with some knowledge of health sciences."

On the left side, there is a navigation menu with the following links: IRIS Home, Basic Information, IRIS Process, A to Z List of IRIS Substances, Advanced Search, Compare IRIS Values, IRIS Guidance, Download IRIS, IRIS Track, Site Help & Tools, Site Overview, IRIS Glossary, Frequent Questions, Tools & Databases, and Related Links.

Below the main description, there are two sections:

- Getting Started with IRIS**: Includes links for "An overview of the web site", "What is IRIS?", and "How does EPA decide which substances to add or update?". A link for "More frequent questions >>" is also present.
- Using the IRIS Database**: Includes links for "IRIS Process (2009 Update)", "Advanced Search in IRIS", "Compare IRIS Values", and "Download IRIS".

On the right side, there is a "Search IRIS by Keyword" section with a search box containing "Arsenic, inorganic" and a "go" button. Below the search box, there are radio buttons for "IRIS Summaries/Toxicological Reviews" and "Arsenic, inorganic". A link for "List of IRIS Substances >>" is also present.

Below the search section, there is an "Ask Peter" section featuring a photo of a man and text: "I'm Peter, the IRIS Virtual Representative. I am an automated response system available weekdays 9 - 5 EST. I can answer questions from the public about the IRIS Assessments from an extensive..."

Human Health Risk Assessment

Step 3 Exposure Assessment

: Average Daily Dose (ADD) calculations for the intake process via the ingestion route (drinking).

$$\text{ADDs} = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

ADDs = Exposure duration (mg/kg-day)

C = Concentration (e.g. µg/L, mg/L) Obtained from samples

IR = Intake rate (e.g. mg/day)

EF = Exposure frequency (day/year) Obtained from subjects

ED = Exposure duration (year)

BW = Body weight (kg)

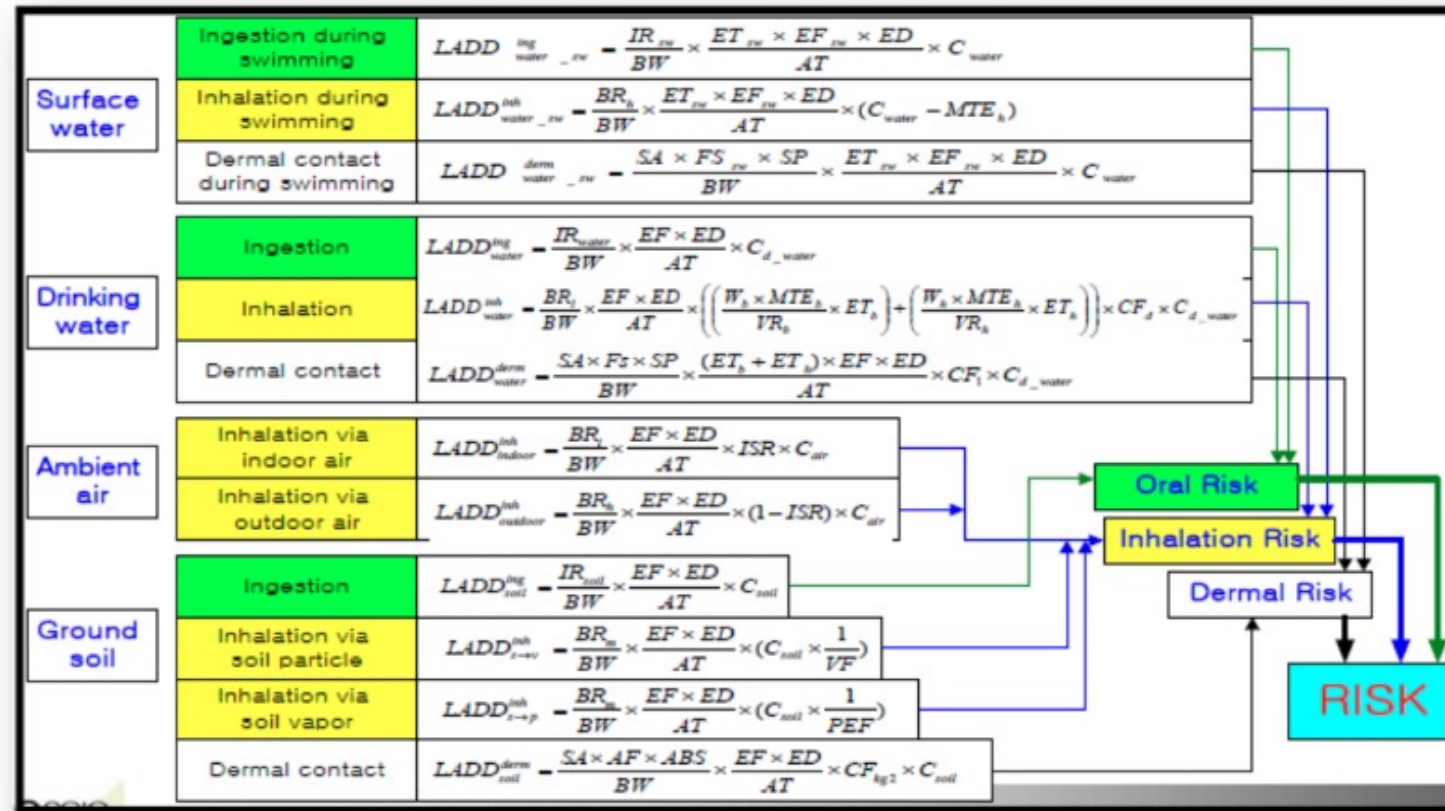
AT = Average time (day)

: for carcinogenic effect, AT = 70 years or 25,550 days



Human Exposure Scenarios

- Environmental Media (4 media)
 - Ambient air, Drinking water, Surface water, Ground soil
- Exposure Routes (12 Pathways)
 - Ingestion, Inhalation, Dermal contact via environmental media



Human Health Risk Assessment

Step 4 Risk Characterization

Carcinogen

$$\text{Cancer Risk} = \text{Exposure} \times \text{SF}$$

; **Exposure** = Lifetime Average Daily Dose or LADDs (mg/kg-day)

SF = Slope Factor (per mg/kg-day)

If acceptable risk = 10^{-6} \Rightarrow **1 in a million**

Cancer Risk $> 10^{-6}$ means Carcinogenic effects of concern

Cancer Risk $\leq 10^{-6}$ means Acceptable level

Human Health Risk Assessment

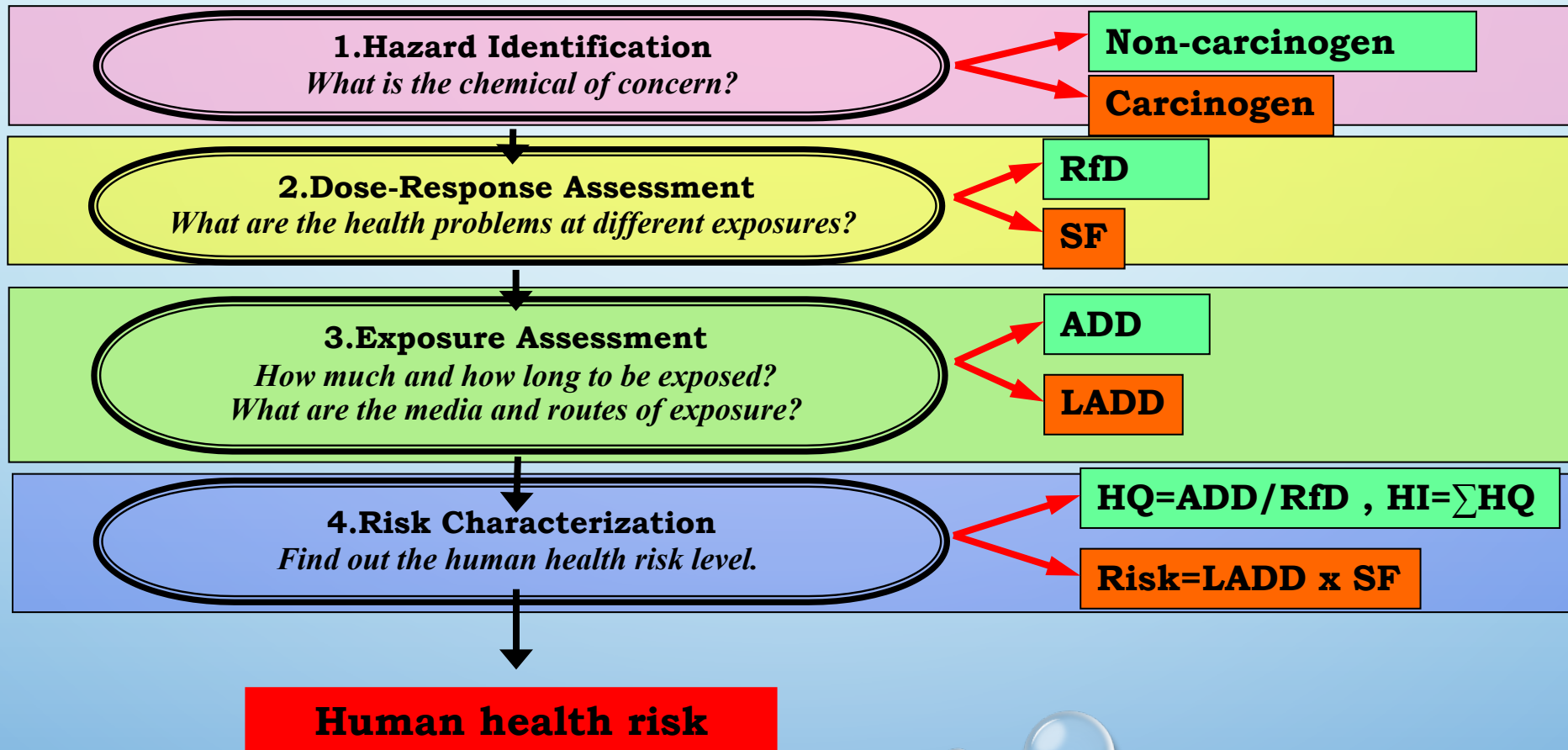
Step 4 Risk Characterization

Non-Carcinogen

$$\text{Hazard Quotient (HQ)} = \frac{\text{Exposure}}{\text{RfD}}$$

$\text{HQ} \geq 1$ Adverse non-carcinogenic effects of concern
 $\text{HQ} < 1$ Acceptable level (no concern)

The Four Step Risk Assessment Process



Case Study

1. Source of Hazard?
2. Hazard Identification?
3. Exposure Route?

Case Study: Agricultural Area at Ubon Ratchathani

Environ Geochem Health (2014) 36:169–182
DOI 10.1007/s10653-013-9537-8

ORIGINAL PAPER

Heavy metal contamination and human health risk assessment in drinking water from shallow groundwater wells in an agricultural area in Ubon Ratchathani province, Thailand

Pokkate Wongsasuluk · Srilert Chotpantarat ·
Wattasit Siriwigong · Mark Robson

Environ Geochem Health
DOI 10.1007/s10653-017-9910-0



ORIGINAL PAPER

Using urine as a biomarker in human exposure risk associated with arsenic and other heavy metals contaminating drinking groundwater in intensively agricultural areas of Thailand

Pokkate Wongsasuluk · Srilert Chotpantarat · Wattasit Siriwigong · Mark Robson

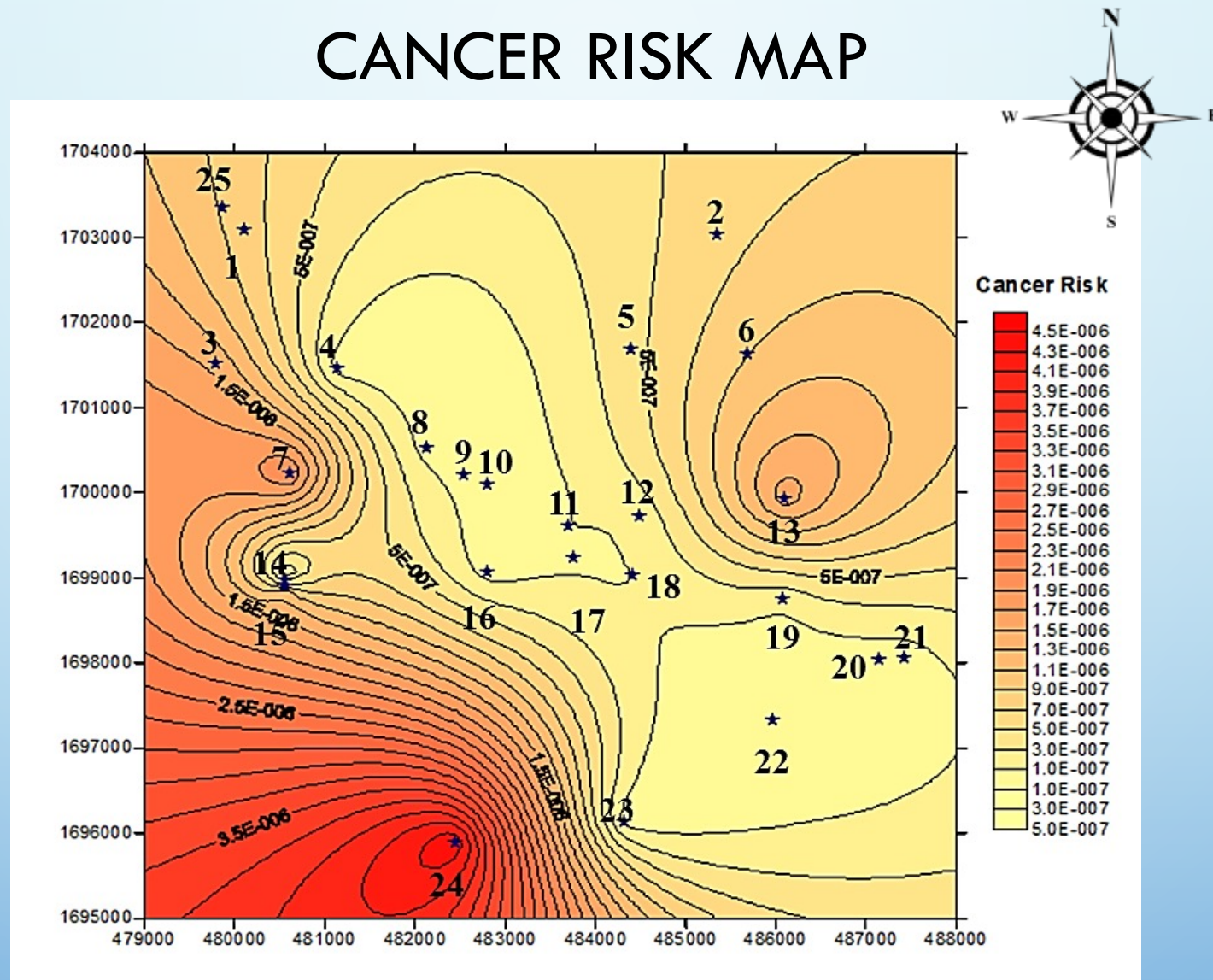


Case Study: Agricultural Area at Ubon Ratchathani

Factors	Group Criterion		
Gender	Male		28 %
	Female		72 %
Weight (kg)	> Median 60.0 <	Avg. 59.9±12.8	Range 30.0-110.0
Height (cm)	> Median 159.0 <	Avg. 157.6±7.31	Range 140.0-176.0
Age (years)	> Median 46.0 <	Avg. 45.8±13.8	Range 18-78
Drinking Rate (L)	> Std. 2 <	Avg. 4.21±2.73	Range 1.25-12.5
Drinking Source		Tap Water	33 %
		Groundwater	58 %
		Buying Bottles	9 %
		(Retail Tap Water)	
Drinking Water Container	Closed or open	Closed Storage	6 %
		Open-Air Storage	84 %
Bath Water Source	Groundwater or	Tap Water	24 %
	Non-Groundwater	Groundwater	76 %
Washing Water Source	Groundwater or	Tap Water	23 %
	Non-Groundwater	Groundwater	77 %
Cooking Water Source	Groundwater or	Tap Water	24 %
	Non-Groundwater	Groundwater	75 %
		Buying Bottles	1 %
		(Retail Tap Water)	

Case Study: Agricultural Area at Ubon Ratchathani

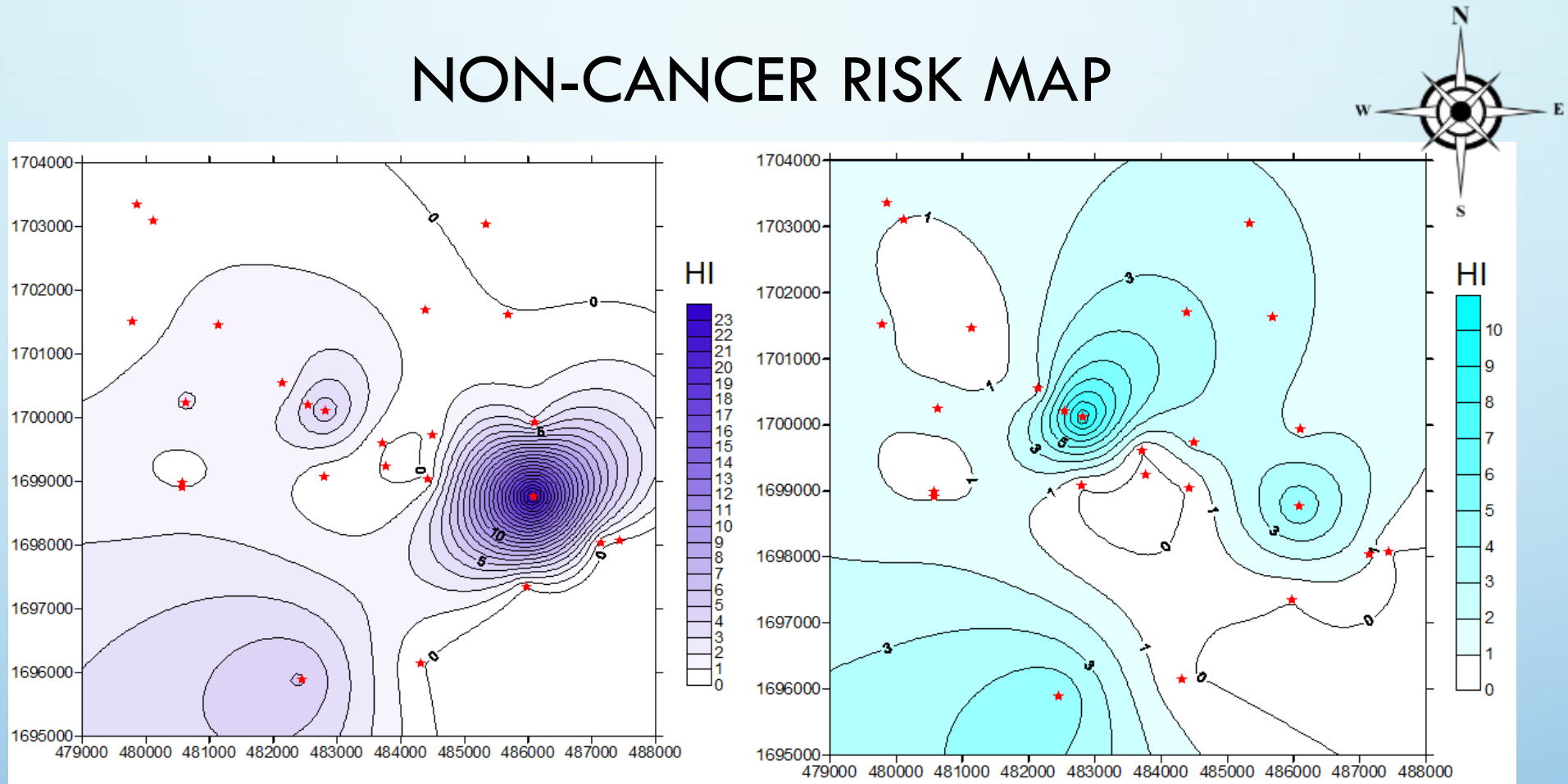
CANCER RISK MAP



(Wongsasuluk et al., 2018)

Case Study: Agricultural Area at Ubon Ratchathani

NON-CANCER RISK MAP



The contour map of hazard index (HI) in dry season and wet season.

Case Study

1. Source of Hazard? => groundwater
2. Hazard Identification? => Heavy metals both carcinogenic and non-carcinogenic
3. Exposure Route? => Oral route

SMALL-SCALE GOLD MINING IN MYANMAR

Digging Soil -> Adding Water -> Sluicing -> Panning -> Amalgamation -> Burning of the Amalgam



SMALL-SCALE GOLD MINING IN MYANMAR

Related health risk assessment of exposure to arsenic and some heavy metals in gold mines in Banmauk Township, Myanmar

Pokkate Wongsasuluk^{1,2✉}, Aung Zaw Tun^{3,4,5}, Srilert Chotpantarat^{6,7} & Wattasit Siriwong¹

Exposure to heavy metals in mining activities is a health issue among miners. This study was carried out at three small-scale gold mining sites situated in Banmauk Township, Myanmar and aims to assess the occupational health risks of small-scale gold miners who are exposed to arsenic (As), cadmium (Cd), mercury (Hg) and lead (Pb) in the soil through the dermal route. Soil samples were analyzed through atomic absorption spectroscopy (AAS). The concentrations of the heavy metals in soils found As, ranged 1.04 mg/kg to 22.17 mg/kg, 0.13 mg/kg to 3.07 mg/kg for Cd, 0.15 mg/kg to 77.44 mg/kg for Hg, and 7.67 mg/kg to 210.00 mg/kg for Pb. In this study, 79% of the participants did not use any form of personal protective equipment (PPE) while working in gold mining processes. Regarding noncancer risk assessment, the results found all hazard quotient were lower than acceptable level ($HQ < 1$). In addition, all hazard index (HI) was lower than 1, the highest HI was found as 5.66×10^{-1} in the amalgamation process. On the other hand, the result found cancer risk ranged from 8.02×10^{-8} to 1.75×10^{-6} , and the estimated cancer risks for 9 years ranged from 4.78×10^{-7} to 1.04×10^{-5} .

Therefore, the cancer risks of the miners were greater than the United State Environmental Protection Agency (U.S. EPA) acceptable cancer risk level, 1×10^{-6} , and the miners may be at risk of developing carcinogenic diseases. The suggestion is to educate miners about the health risks of heavy metals and to encourage the use of proper PPE all the time while working in gold mine.

The concentration of heavy metals in soil at gold mining:

As ranged from 1.04 to 22.17 mg/kg;
Cd ranged from 0.13 to 3.07 mg/kg;
Hg ranged from 0.15 to 77.44 mg/kg;
Pb ranged from 7.67 to 210.00 mg/kg.

No non-cancer risk, however, found cancer risk.

Case Study

1. Source of Hazard? => **gold-mining soil**
2. Hazard Identification? => **Heavy metals both carcinogenic and non-carcinogenic**
3. Exposure Route? => **Dermal route**

Class Activity

Let's try!!



Qualitative Risk Assessment

เหตุการณ์น้ำมันดิบรั่วไหล จากจุดขนถ่าย
น้ำมันในทะเล ที่บริเวณนิคมอุตสาหกรรมมาบ
ตาพุด อำเภอเมือง จังหวัดระยอง เมื่อวันที่ 25
มกราคม 2565 คราบน้ำมันกระจายตัว ปกคลุม
ผิวน้ำทะเล และชายฝั่งบริเวณอ่าวไทย



Please present any harmful then please design
“Qualitative Risk Matrix”.



FREQUENCY	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5
SEVERITY					

Impact	Likelihood				
	Rare	Unlikely	Possible	Likely	Almost certain
Catastrophic	moderate	moderate	high	critical	critical
Major	low	moderate	moderate	high	critical
Moderate	low	moderate	moderate	moderate	high
Minor	very low	low	moderate	moderate	moderate
Insignificant	very low	very low	low	low	moderate

Quantitative Risk Assessment

Case A: River water is contaminated with **arsenic 55 ug/L** and **lead 20 ug/L** from industrial wastewater discharge.

Case B: Soil at agricultural area nearby industrial plants found **arsenic 60 mg/kg** and **cadmium 30 mg/kg**.

- Choose 1 case study.
- Choose 1 exposure route.
- Choose 1 heavy metal.
- Calculate 1 Risk assessment (choose cancer, non, both?).
- Use your personal information or references to calculate.

- The End -

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