

METHODS AND TOOLS

DETERMINING MERCURY USE IN THE ARTISANAL AND SMALL-SCALE GOLD MINING (ASGM) SECTOR



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UN
environment

Lecture 3 Collecting Baseline Information



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Collecting Baseline Information: Tools, Techniques and Approaches

Overview

- Sources of Information
- National Level Scoping
- Field Data Collection Approaches
 - Observations and General Descriptions
 - Interviews
 - Counts and Measures
 - Physical Tools for Data Acquisition
- Data Analysis
- Step by Step Approach

Sources of information

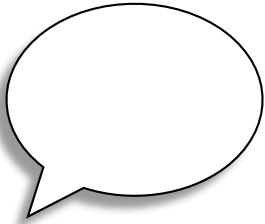
- Literature
 - Stakeholders
 - Official export data
 - Physical measurements
 - Universities
 - NGOs
 - Donor Agencies
(GEF GOLD, World Bank, GMP)
 - Others?
- National & Regional Government
(Mines & Environment)
 - LSM
 - Local Authorities
 - Municipalities
 - Mining Groups
 - Gold Buyers & Exporters
 - **MINERS!**

1. National Sector Scoping



Literature
Review

{ Official trade data, peer-reviewed journals, white papers from LSM, NGOs, GMP, World Bank, GEF GOLD



Interviews with
Stakeholders

{ Government (Mines, Environment, etc), NGOs, Universities, LSM companies, national gold buying houses, gold exporters



Visits to the
capital & major
mining hubs

{ Regional & municipal government offices, mayors office, regional gold traders, mining cooperatives



Visits to a few
ASGM sites

{ On-the-ground realities, technology, access

1. National Sector Scoping



Literature
Review



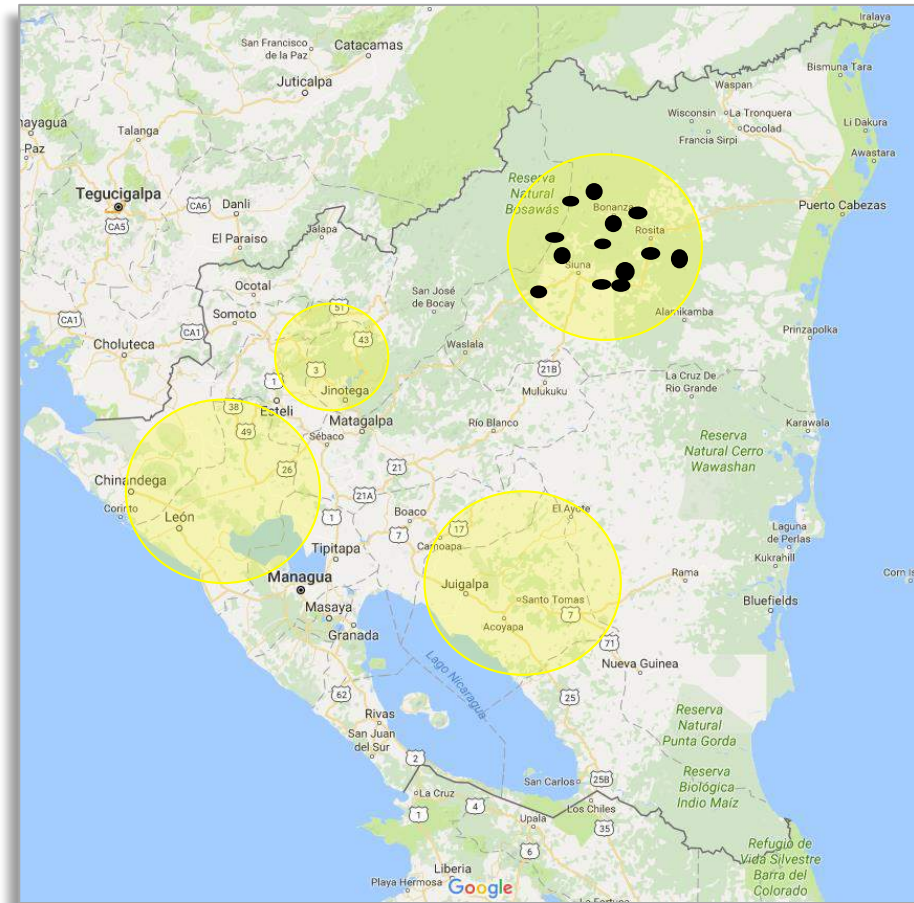
Interviews with
Stakeholders



Visits to the
capital & major
mining hubs



Visits to a few
ASGM sites



1. National Sector Scoping



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Literature
Review



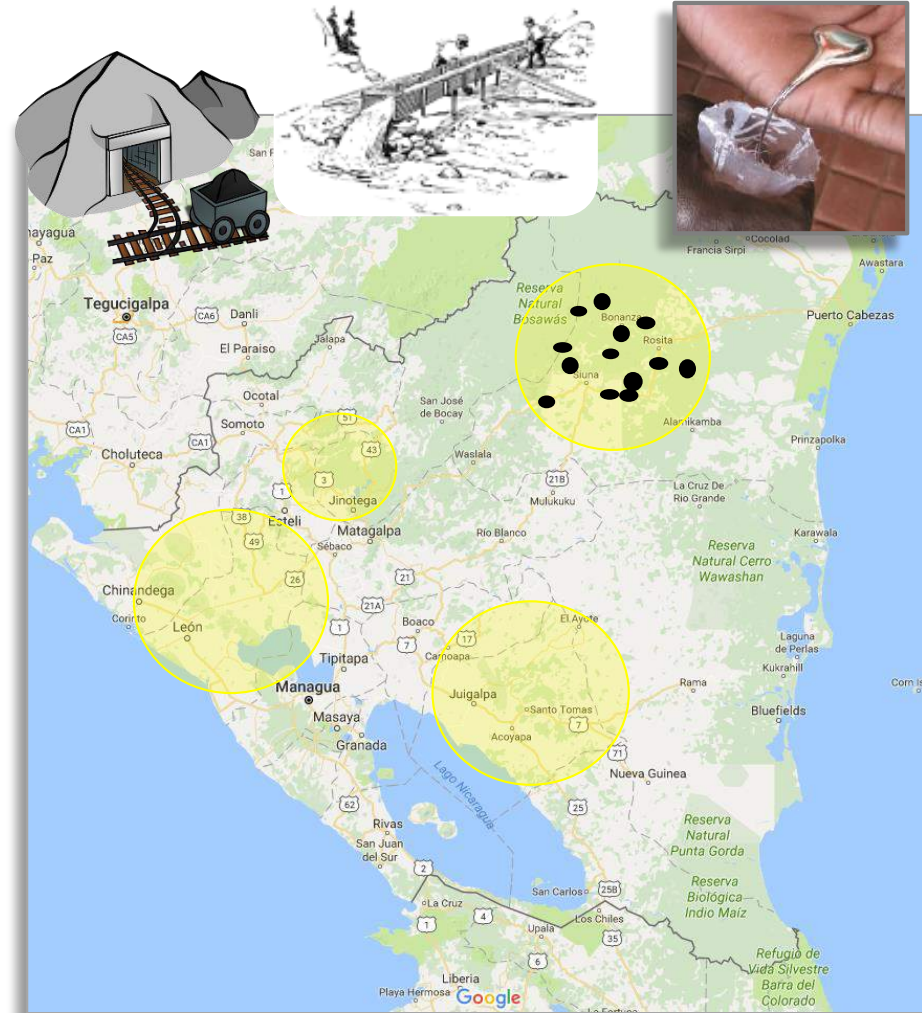
Interviews with
Stakeholders



Visits to the
capital & major
mining hubs



Visits to a few
ASGM sites



1. National Sector Scoping



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Literature
Review



Interviews with
Stakeholders



Visits to the
capital & major
mining hubs



Visits to a few
ASGM sites



1. National Sector Scoping



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Literature
Review



Interviews with
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Visits to the
capital & major
mining hubs



Visits to a few
ASGM sites





Visits to a few ASGM sites

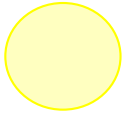


2. Design a Research Plan



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Identify regions & region data



Identify missing data

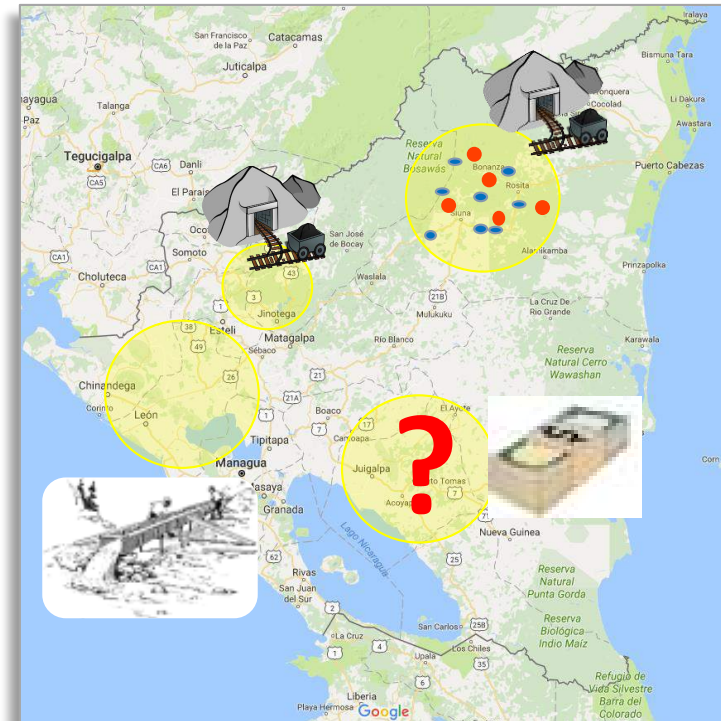


Select approaches *per region*



Determine information
needed

Outline Field Data Collection



3. Collecting Field Data



Tools



General Site Assessment Form (to be completed inventory specialist based on observations)

Note: If there is a person in charge of the site (from the town/council, police, concession holder, etc) then they should be interviewed and if possible assist in collecting the information on this sheet.

General Site Information

General Information	
Inventory Officer:	Date:
Region:	Closest Community:
Site Name:	GPS: X Y Datum:
Estimated Site Workforce:	Style of Mining:
Processing style:	Formal Status on site:
How many gold buyers in community:	Evidence of mercury use:
Contact Information:	
General Description of Site:	
...	
General Description of site Governance (Individual? Groups? Bosses? Do miners rent systems, do they get daily wage, % of production, Etc):	
...	

Extraction Information

Extraction Information	
Type of Ore: Hard Rock / Soft Rock / Both	Extraction Teams: Individual / Group / Both
Extraction Method:	Estimated total Miners on site:
# Open Pits:	# Shafts:
# Miners per open pit:	# Miners per shaft:
Open pit extraction method:	Shaft extraction method:
Daily extraction per miner (open pit):	Daily extraction per miner (shaft):
Unit of measure and weight per unit:	Days active per year:
Extraction Comments:	

Processing Information

Processing Information 1 (Do for each general processing workflow observed on Site)	
Type of Processing system:	Estimated total Processors for this style system:
# of processing systems:	Processing per processor:
# Processors per system:	Whole ore or concentrate amalgamation:
Is mercury used in upgrading?	
Comments/ description of processing workflow:	



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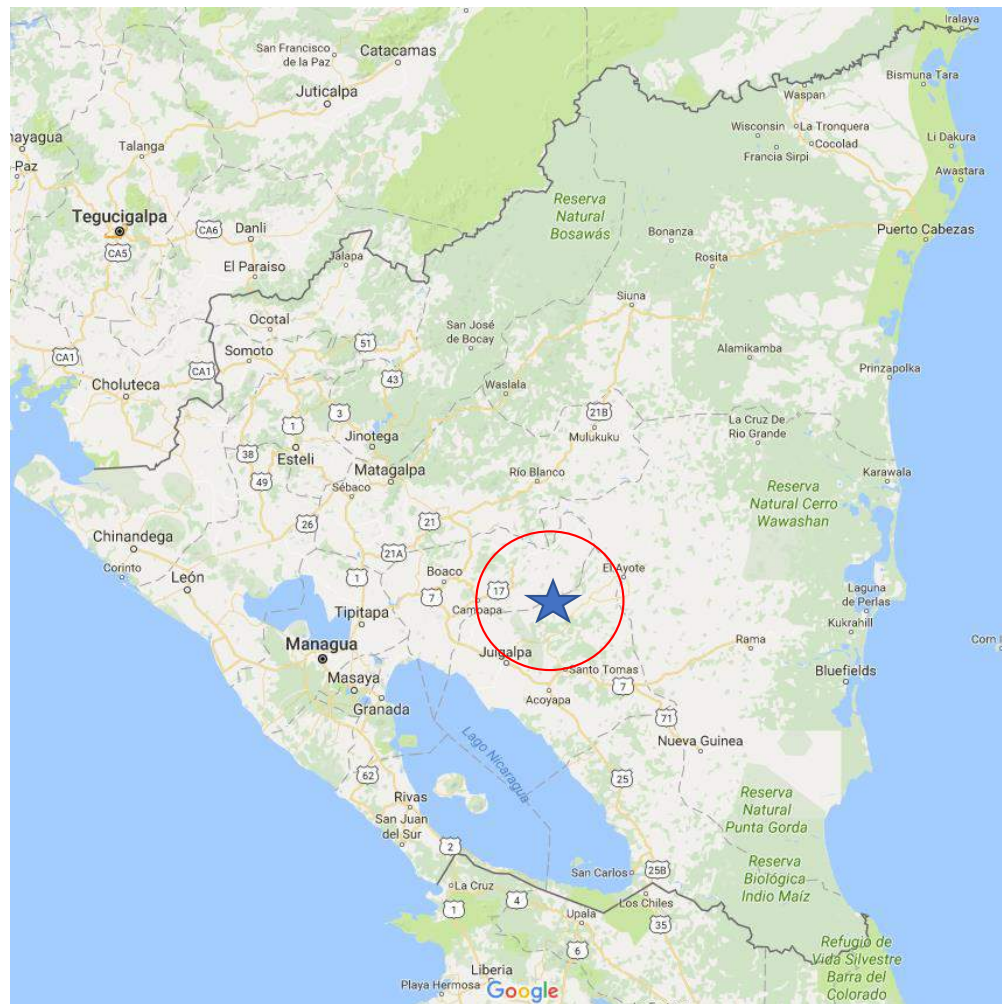


Step by Step Approach

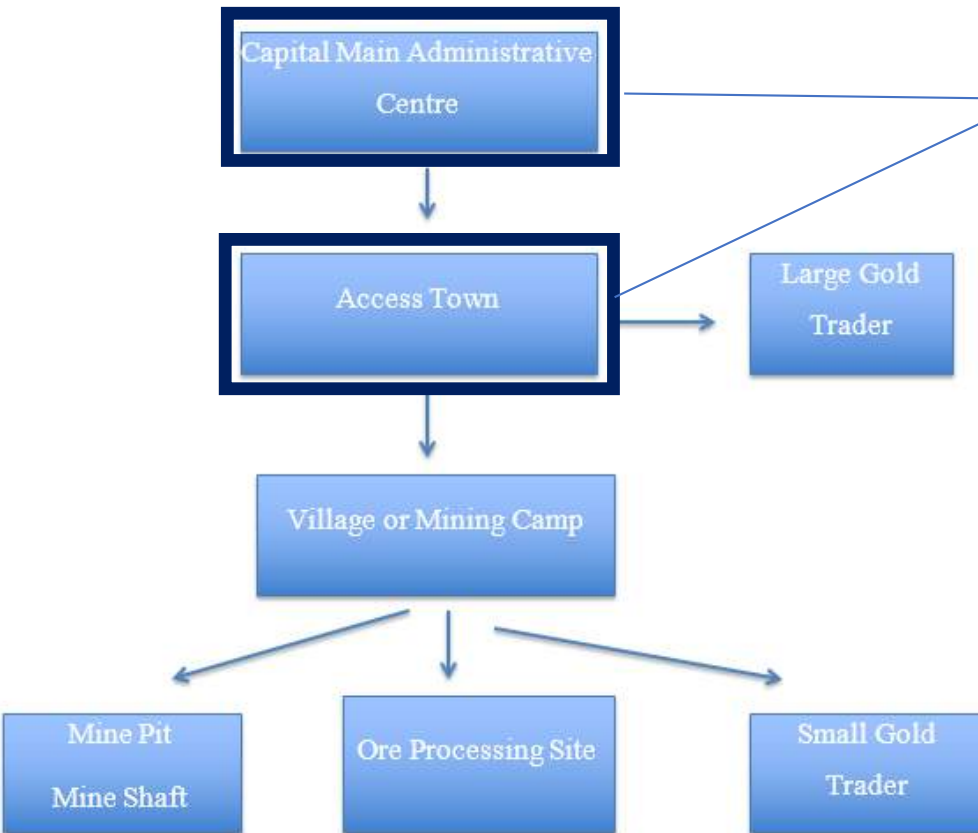


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1. Visit Regional Stakeholders
2. Visit Mining Communities
3. Meet Authorities
4. Visit extraction / processing sites
5. Casual introductions
6. Observations
7. Worker Interviews
8. Other local interviews?
9. Revise and compile data daily
10. Site and regional estimates
11. Adjust as necessary!



Step-by-Step Approach

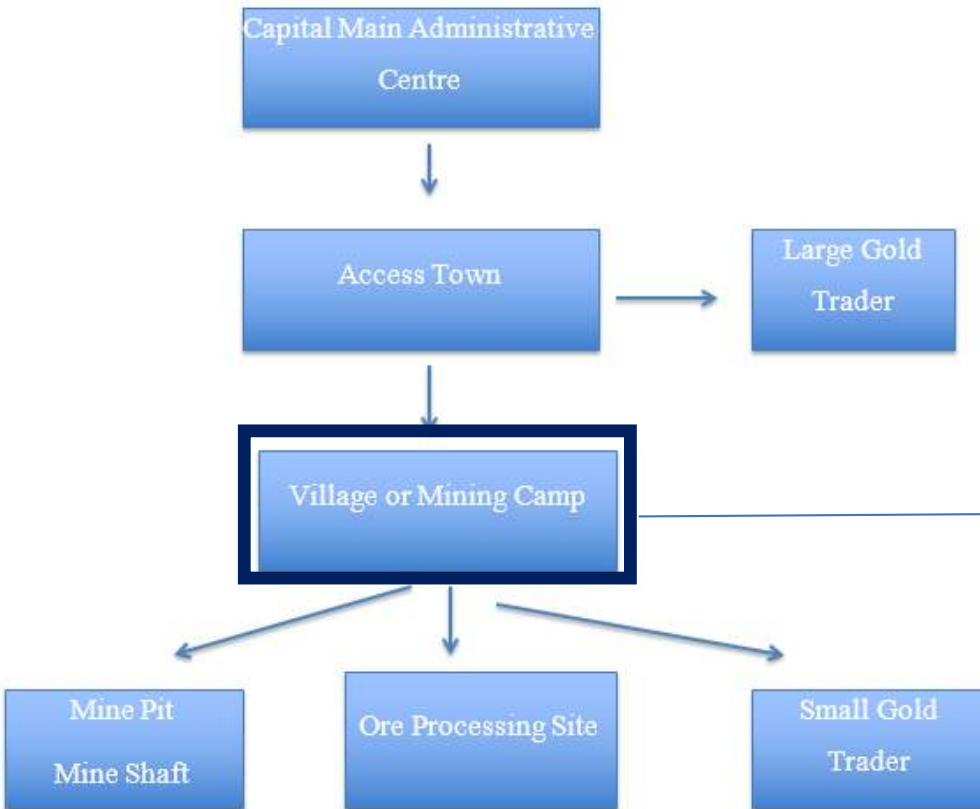


Capital & Access Town

1. Meet with government and administrative officials + local authority. Explain project & obtain permission



Step-by-Step Approach



Community



1. Meet with local authority
2. Explain project
3. **Community Interview Form**
collect info about mining here
(will be general)

Village or Mining Camp Data Form			
Location			
Name of Village/Camp		Latitude	
Name of Mine Site		Longitude	
Province		Date	
Department/County		Time	
Site Accessibility			
Access Route (Description)		River A	

Community

A Note on Interviews

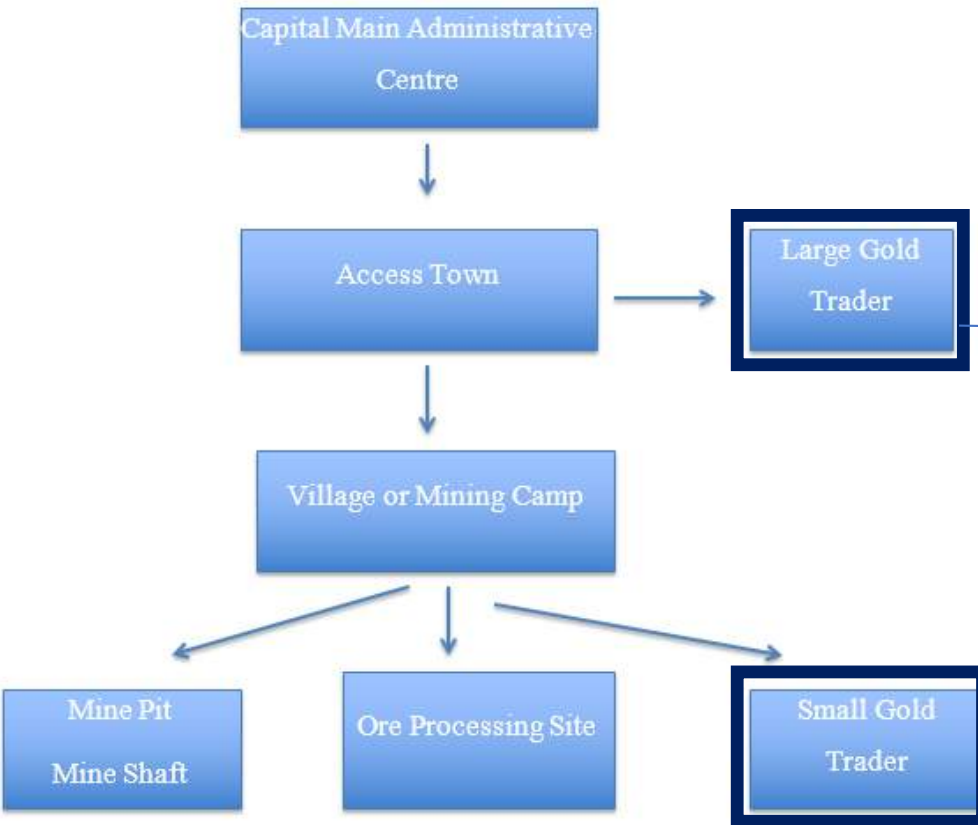
- Informal is better
- Build relationship and trust first
- Best to isolate one person for the interview
- **It`s a conversation**
- Ask questions first, take notes later
- Ask different questions to allow you to come to the same answers different ways
 - Evaluate answers as you go!
- Do NOT simply read questions off a sheet
 - Use survey sheets as a guide
- **Analyse information during or immediately following interview**



1. Meet with local authority
2. Explain project
3. **Community Interview Form**
collect info about mining here
(will be general)

Village or Mining Camp Data Form			
Location			
Name of Village/Camp		Latitude	
Name of Mine Site		Longitude	
Province		Date	
Department/County		Time	
Site Accessibility			
Access Route (Description)		River A	

Step-by-Step Approach



Gold Traders



1. Meet with head of gold house
2. **Interview**, referring to the **Gold Trader Form**
3. Start with questions about gold (price, amount purchased, types, grades)
4. Ask to see some gold. Check for Hg use. Take a photo.

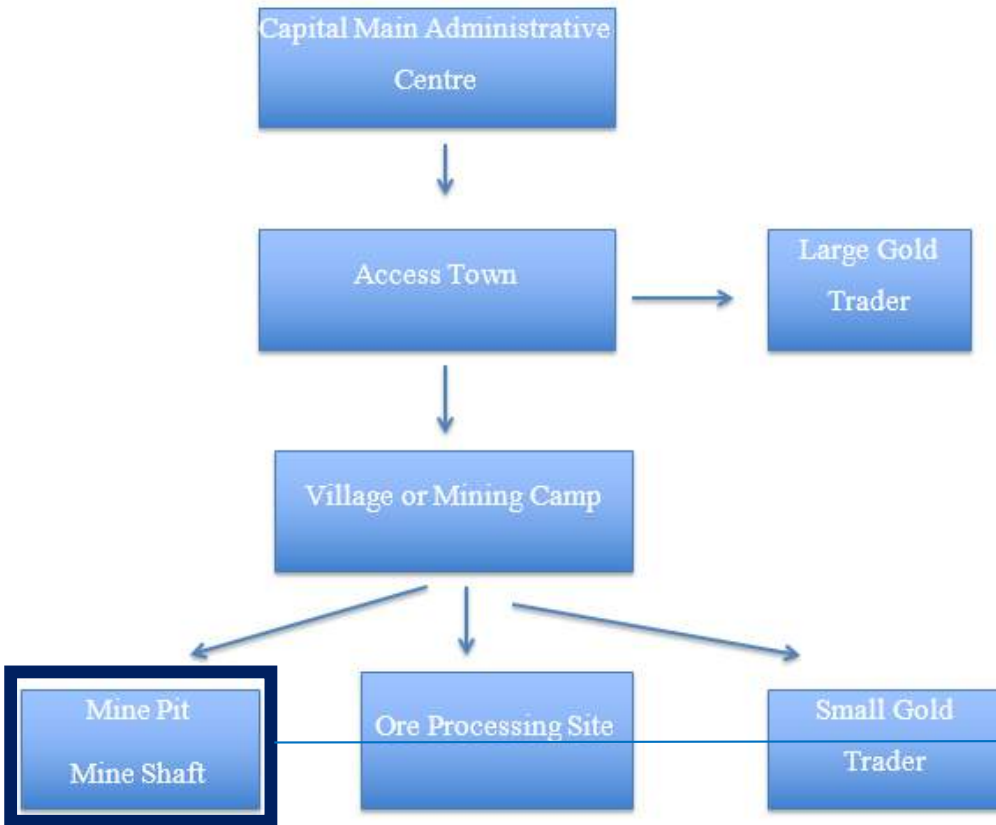
Gold Buying/Trading House Data Form

Location Information

Name of gold trader:

Tel		Date	
Email		Time	
Address			
City			

Step-by-Step Approach



Extraction Site

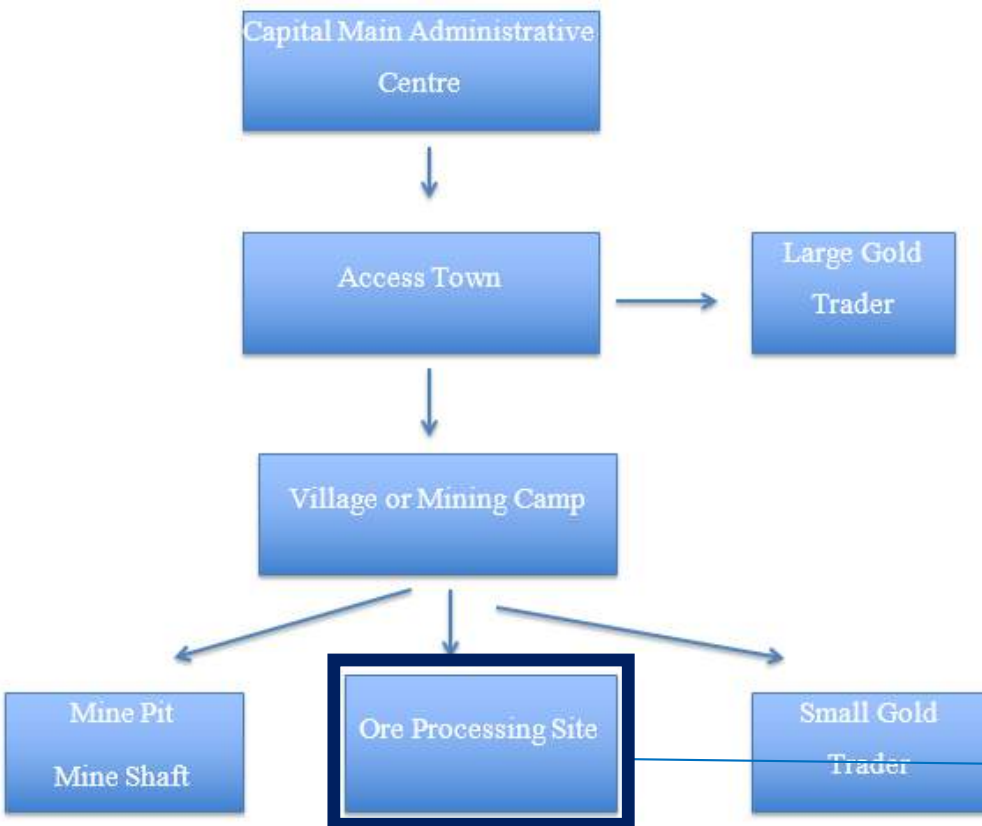


1. Scan site and determine practical approaches. Begin to fill out [ASGM General Observations](#)
2. Go to a pit/shaft, identify self
3. Interview the pit/shaft boss and miners specific to the pit/shaft
4. Use [ASGM Site Interview Form](#)

General Site Information	
General Information	
Int	Miner Processor Pit Boss Processor Boss Group Leader Site Leader
Re	
Si	General Information (from inventory officer observations)
Es	Inventory Officer: Date:
	Region: Closest Community:
	Site Name: Mining Group Name:
	Person Interviewed: Role of Person Interviewed:
	Estimated Site / Group Workforce:



Step-by-Step Approach



Processing Site

General Site Information	
General Information	
Inventory Officer:	Date
Reg: Miner Processor Pit Boss Processor	
Site:	
General Information (from inventory officer)	
Inventory Officer:	
Reg:	
Site:	
Pers:	
Est:	
Mercury Inventory Form	
Location	
Name of Village/Camp	
Name of Mine Site	
Province	
Department/County	



1. Fill **ASGM General Observations**
2. Go to a processing team, identify self & explain project
3. Observe the processing workflow, noting steps, equipment & where Hg is used.
3. Go to each step & interview. Use **ASGM Site Interview Form**
4. Do detailed mercury measurement to find Hg:Au ratio
5. Use **Hg:Au Form**



Ways of Collecting Information



Interviews

with miners, processors, bosses, land owners, gold traders



Direct Observation

Type of mineral, mining/processing workflows, mercury use, site governance, socio-economic variables



Counts

Pits, shafts, processing systems, miners, bags of ore...



Weight

Bag of ore, mercury added/recovered, amalgam produced, gold produced...



Volume

Mercury added/recovered, water throughput...



GPS

Location, spatial distribution

Conducting Interviews

- Informal is better
- Build relationship and trust first
- Best to isolate one person for the interview
- **It`s a conversation**
- Ask questions first, take notes later
- Ask different questions to allow you to come to the same answers different ways
 - Evaluate answers as you go!
- Do NOT simply read questions off a sheet
 - Use survey sheets as a guide
- **Analyse information during or immediately following interview**

Analysing Data During Interview

Q. How much ore do you process in a day? A. 1 tonne

Q. How many bags of ore do you process in a day? A. 15

Q. How much does a bag of ore weigh? A. 100 kg

Analysing Data After Interview



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Processor #1:

- Throughput = 1 T/d
- Recovery = 60 g/T
- Days Active = 6 / wk
- Month Prod = ~250 g

Processor #2:

- Throughput = 10 bags/d
- Measure: 100 kg/bag*
- Observe: 2.5 bag/6 hr*
- Recovery = 1 g/bag
 - Days Active = 25 / month
 - Month Prod = ~200 g

Processor #1:

- Throughput = 1 T/d
- Recovery = **10-15 g/T**
(use 12.5 g/T)
- Month Prod = ~250 g

Calculate Production:

- Daily = 60 g/d
- Month = 1440 g/month



Calculate Production:

- Throughput = 1 T/d
- Production = 10 g/d
- Month = 250 g/month

Calculate Production:

- Daily = 12.5 g/d
- Month = 300 g/month



Site Counts

- Visit sites and make counts of select characteristics
 - Active Pits
 - Active Processing systems
 - Workers per pit or system
 - Extraction per or throughput per system



Site Counts

For large sites or communities hire a local miner to show you around the site!

Counts at ALL sites in a region?

- *Couple with site authority interview?*
- *Triangulate with other regional information?*



Physical Measurements



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- Mercury measurements
- Gold Measurements
- Ore bag measurements
- Throughput



Hg:Au Ratio



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Example: measuring the Hg:Au ratio for concentrate amalgam



1. Weigh the total amount of mercury before it is applied to the concentrated ore.



2. Weigh the excess mercury not forming a part of the amalgam.



3. If possible, weigh the amalgam formed after mixing the mercury with the concentrated ore, to better understand the loss of mercury to air versus water/soil.

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Example (continued)



4. Weigh the sponge gold remaining after burning.

5. If possible, weigh the gold doré after the sponge gold has been melted in order to understand the % of residual mercury remaining in the sponge (often 5%). This is valuable to know, because sponge gold is often burned in gold shops, located in populated areas.



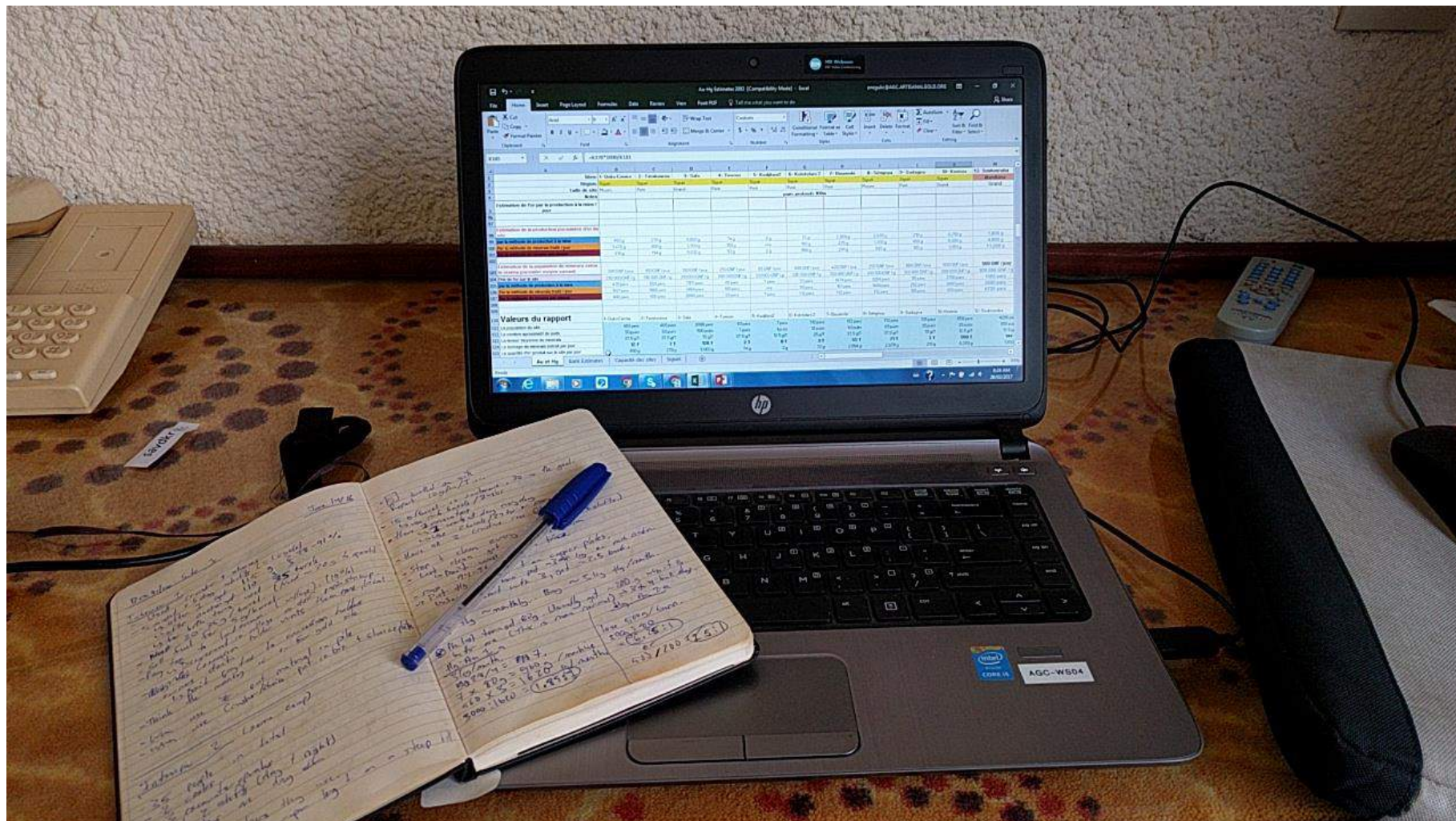
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Data Analysis

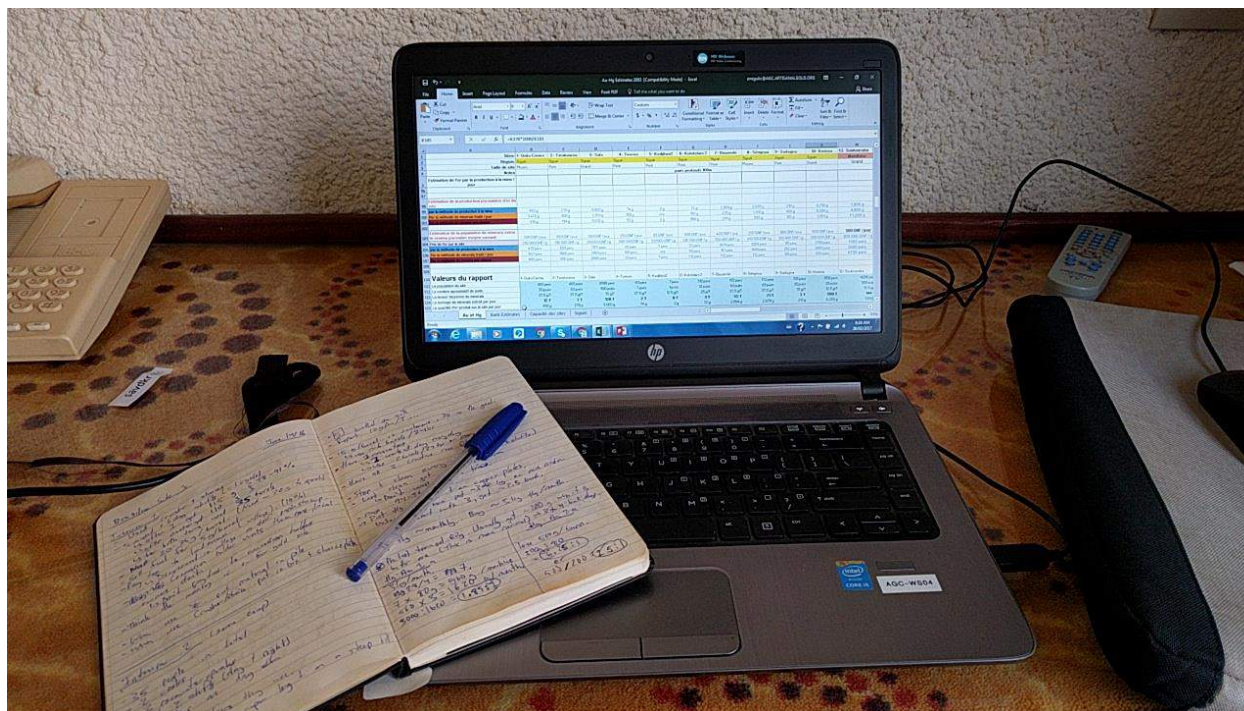


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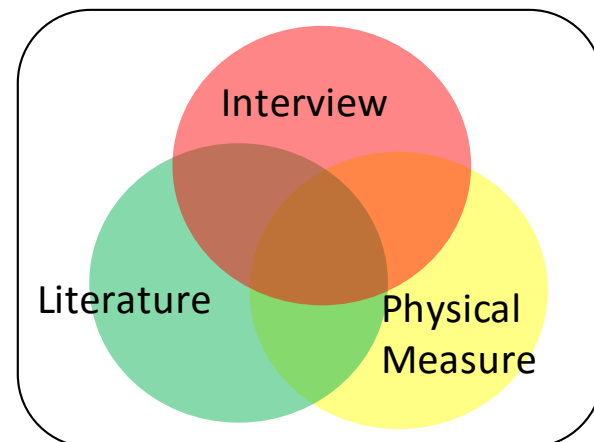
Data Analysis

- Review and organize field data daily
- Assess data collected to ensure you have information needed for regional extrapolations
- Adjust field approaches as needed to ensure collection of useful data



Data Analysis

- Must compile and organize data
- Determine which site data to use for regional estimates, and how to extrapolate
- Couple site data with existing information to compare, and produce regional and national estimates
- Compare estimates from different sources, and review to determine best estimates
- Use logic, triangulation, and gather extra information where needed



Excel Sheets: Unit Conversion



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Quantity of Gold

informal unit for weight of gold	blade	
grams per informal unit for weight of gold	1.3	g/blade
weight of gold, in informal units (blade)	10	blades
weight of gold, in grams (g)	13	g

Purity of Gold

gold purity in karats	18	K
gold purity in %	75%	

Quantity of Ore

informal unit for weight of ore	sack	
kg per informal unit for weight of ore	60	kg/sack
tonnes informal unit for weight of ore	0.06	T/sack
weight of ore, in informal units (sack)	100	sacks
weight of ore, in tonnes (T)	6	T

Grade of Ore

informal unit for ore grade	g/sack	
unit for weight of gold	g	
grams per unit of gold weight (g)	1	g/g
unit for weight of ore	sack	
tonnes per unit of ore weight (sack)	0.06	T/sack
ore grade in informal units (g/sack)	2	g/sack
ore grade in ISO units (g/T)	33.33	g/T

Excel Sheets: Site Estimates



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Enter location information

ASGM Site: Korfalo | Location Information

ASGM Site	Korfalo
Concession/Mining Title	-
ASGM Mining Region	Godu
Lat	1.216667
Long	123.500000
GPS device & datum	Trimble handheld GPS, NAD83

Associated Communities	Kafala
County / District	Malika District
Province / State / Department	Godu Province
Country	Goldaguay

Date(s) of data collection	Oct 30, 2017
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Name of field researcher	Marie Cooke
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Site contact(s): name	Ana Fleur	Eli Strong	Jim Jones	
role	Community Chief	Mining Coordinator	Cooperative Leader	
phone number	1(234)567-1234	1(234)567-8910		
email			jjones@email.com	

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ASGM Site: Placerton | Interviews with ASGM workers about Extraction

Data Collection Form "ASGM Site Interview: Extraction"

Extraction Unit Interviews - Extraction Type 1	Interview 1	Interview 2	Interview 3	Interview 4	Interview 5	Interview 6	Interview 7	Interview 8
Data entry								
interviewee type	EXTRACTION WORKER	EXTRACTION BOSS						
interviewee name	Eli	Jonas						
ore grade (g/T)	10	10						
gold purity (%)	70%	70%						
daily extraction per miner (T ore/shift)	0.1	0.1						
average active miners per unit	10	10						
number of units on site - total	20	20						
number of units on site - active	10	11						
shift length (hr)	8	8						
shifts per day	2	2						
days active per week (d/w)	6	6						
months active per year (m/y)	10	10						
days active per year (d/y)	200	200						
daily earnings per miner (g 24K Au)	0.5	0.5						
annual earning per miner (g 24K Au)	100	120						
price per g of pure gold (local currency/g 24K Au)	38	35						
price per g of pure gold (\$USD/g 24K Au)	\$38.00	\$35.00						
Calculations of site-level information								
total miners on site (assumed = miners active/d)	200	220	---	---	---	---	---	---
daily ore extraction per unit (T ore/d/unit)	2	2	---	---	---	---	---	---
daily ore extraction on site (T ore/d/site)	20	22	---	---	---	---	---	---
yearly ore extraction on site (T ore/y/site)	4,000	4,400	---	---	---	---	---	---
yearly Au extracted on site - impure (kg Au/y/site)	40	44	---	---	---	---	---	---
yearly Au extracted on site - pure (kg Au/y/site)	28	31	---	---	---	---	---	---
value of yearly Au extracted on site (local currency/y/site)	1,064,000	1,078,000	---	---	---	---	---	---
value produced yearly per miner (local currency/y/miner)	5,320	4,900	---	---	---	---	---	---
value produced yearly per miner (\$USD/y/miner)	\$5,320	\$4,900	---	---	---	---	---	---

Excel Sheets: Site Estimates



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Calculate - Useful variable averages:

		Site Interviews	
		Mean	Range
Extraction Type 1			
	daily extraction per miner (T ore/shift)	0.1	0.1 - 0.1
	average active miners per unit	10	10 - 10
	shift length (hr)	8	8 - 8
	shifts per day	2	2 - 2
	days active per year (d/y)	200	200 - 200
	daily earnings per miner (g 24K Au)	0.5	0.5 - 0.5
	annual earning per miner (g 24K Au)	110	100 - 120
	daily ore extraction per unit (T ore/d/unit)	2.0	2 - 2
	value produced yearly per miner (local currency/y/miner)	5,110	4900 - 5320
Mineralogy			
	ore grade (g/T)	6.0	2 - 10
	gold purity (%)	80%	70 - 90%
Trade			
	price per g of pure gold (local currency/g 24K Au)	38.00	38 - 38
	price per kg of mercury (local currency/kg Hg)	---	0 - 0
	purchased by miners per year, mercury, entire site (kg Hg/y)	---	0 - 0
	purchased by sellers per year, mercury, entire site (kg Hg/y)	---	0 - 0

Excel Sheets: Site Estimates



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Calculate - Baseline Estimates for the Site:

Site-Level Baseline Estimates for Placerton

ASGM Ore Production (T 24-K Au/y)		Mean	Range
Extraction-based		20,800	18000 – 23600
Processing-based		20,940	19000 – 22880
Transport-based		4,560	4000 – 5120
average		15,433	
ASGM Gold Production (kg 24-K Au/y)			
Extraction-based		59.3	53 – 65
Processing-based		58.9	55 – 63
Transport-based		31.9	28 – 36
Trade-based (bought by gold traders)		25.6	25 – 26
average		50.0	
ASGM Mercury Use (kg Hg/y)			
Extraction-based		252	
Processing-based		250	
Trade-based (total sold by Hg sellers)		---	0 – 0
Trade-based (total bought by miners)		---	0 – 0
Transport-based		136	
average		213	
Workforce			
Extraction Workers (extraction-based)		430	400 – 460
Processing Workers (processing-based)		408	400 – 416
Transport Workers (transport-based)		30	28 – 32
total		868	

These variables
(highlighted in yellow) go in
the "Region Baseline Calcs"
tab of the Region Workbook.

Gold per Processing Type			
	kg	% of total	Hg:Au Ratio
Type 1	28.6	48%	6.87
Type 2	30.3	52%	1.79
Type 3	0	0%	0

Excel Sheets: Region Summary



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Summarize all useful variable averages in the region:
(used later for extrapolation)



ASGM REGION: Goldu

Region name

Goldu

Key Variable Statistics for ASGM Sites in Goldu

Variable	Site 1 Placerton		Site 2 [site name]		Site 3 [site name]		Site 4 [site name]		Site 5 [site name]	
	mean	range	mean	range	mean	range	mean	range	mean	range
Mineralogy										
ore grade (g/T)	9.0									
gold purity (%)	73%									
Trade										
price per g of pure gold (local currency/g 24K Au)	37.25									
price per kg of mercury (local currency/kg Hg)	---									
purchased by miners per year, mercury, entire site (kg Hg/y)	---									
purchased by sellers per year, mercury, entire site (kg Hg/y)	---									
Extraction Type 1										
daily extraction per miner (T ore/shift)	0.1	0.1 – 0.1								
average active miners per unit	10.000	10 – 10								
shift length (hr)	8	8 – 8								
shifts per day	2	2 – 2								
days active per year (d/y)	200.0	200 – 200								
daily earnings per miner (g 24K Au)	0.5	0.5 – 0.5								
annual earning per miner (g 24K Au)	110	100 – 120								
daily ore extraction per unit (T ore/d/unit)	2	2 – 2								
value produced yearly per miner (local currency/y/miner)	5110	4900 – 5320								
Extraction Type 2										
daily extraction per miner (T ore/shift)	0	0.35 – 0.4								
average active miners per unit	55	50 – 60								
shift length (hr)	8.00	8 – 8								
shifts per day	2.0	2 – 2								
days active per year (d/y)	200.0	200 – 200								
daily earnings per miner (g 24K Au)	1	0.5 – 0.5								
annual earning per miner (g 24K Au)	90.0	80 – 100								
daily ore extraction per unit (T ore/d/unit)	42	35 – 48								
value produced yearly per miner (local currency/y/miner)	4914.00	4788 – 5040								
Extraction Type 3										
daily extraction per miner (T ore/shift)	---	0 – 0								
average active miners per unit	---	0 – 0								
shift length (hr)	---	0 – 0								
shifts per day	---	0 – 0								
days active per year (d/y)	---	0 – 0								

Excel Sheets: Region

Calculate - Baseline Estimates for the Region

Approach 1

Visited all sites? Add estimates from all sites!

Approach 1: Collect site-specific data for ALL sites. Sum data for ALL sites in the region

Add data for all sites below (use data collected from site visits, plus additional info from stakeholders). Add together to get the regional baseline estimates.

Table 1. Summing the results of all regions

	Site 1 Placerton	Site 2 [site name]	Site 3 [site name]	Site 4 [site name]	Site 5 [site name]	Site 6 [site name]	Site 7 [site name]	Site 8 [site name]	Site 9 [site name]
ASGM Gold Production (kg/y)	50	60	45	34	43	43	18	90	
ASGM Mercury Use (kg/y)	213	300	225	170	215	215	90	450	
ASGM workforce	868	45	346	324	123	54	32	12	

Excel Sheets: Region



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Calculate - Baseline Estimates for the Region

Approach 2

Visited a subset of sites? Extrapolate regional estimates using the variable averages and pieces of information about the region

Approach 2: Collect averages of common variables by visiting a subset of sites (previous tab - 'All Sites'). Find baseline estimates by combining these variables with pieces of regional information			
Add all known data for the region (immediately below). Add key averages of information collected at your subset of sites (previous tab).			
Table 2A. Available information about the region. Add all known region data here.			
General		source	source
	Ore Grade (g/T)		
	Gold Purity (%)		
Extraction	Total ASGM Workforce		
	Annual Gold Production (T/y)		
	total miner workforce		
Processing	% of workforce miners		
	no. of mining sites - total		
	no. of mining sites - med		
Other	no. of mining sites - small		
	no. of extraction units		
	processor workforce		
	% of workforce processors		
	no. of mining sites		
	No. of processing sites - total		
	No. of processing sites - large		
	No. of processing sites - med		
	No. of processing sites - small		
	no. of processing systems type 1		
	no. of processing systems type 2		
	no. of processing systems type 3		
	Hg:Au Ratio		

Table 2B. Extrapolation and Cross-check Exercises. Combine Region Data (Table 2A., directly above) and Site-based Average Data (previous tab).			
View comments embedded in cells for calculation suggestions. These calculations are not the only options available. Regional estimates can be calculated in many different ways. These ways will be specific to the country, the region, and the information that has been collected from ASGM sites, and the regional information available. Add to the table below as per methodology defined by your team.			
		Regional Estimates	Comments
Region Data: Workforce Site-based Data: Extraction Info			
Total Number of Miners			
Annual Gold Production (T)			
Annual Hg use (T)			
Region Data: Gold Production Site-based Data: Extraction & Processing Info			
Total Gold production			
Total ASGM workforce			
Region Data: Number of Extraction Sites Site-based Data: Extraction Info			
Number of large mining sites			
Number of medium mining sites			
Number of small mining sites			
Average miner workforce of large sites			
Average miner workforce of medium sites			
Average miner workforce of small sites			
Total Miner Workforce			
Total ASGM Workforce			
Annual Au Production			
Region Data: Counts of Processing Systems Site-based Data: Processing Info			
Processing systems 1 in region			
Annual Au Production 1			
Annual Hg use 1			
ASGM workforce 1			
Processing systems 2 in region			
Annual Au Production 2			
Annual Hg use 2			
ASGM workforce 2			
Processing systems 3 in region			
Annual Au Production 3			
Annual Hg use 3			

Excel Sheets: Country

Calculate - Baseline Estimates for the country:

Sum the final estimates from all regions



UN
environment

[COUNTRY NAME]

Final Baseline Estimates of Mercury Use, Gold Production, and Workforce for the Country

Calculate baseline estimates for ALL regions. Sum data for ALL regions to obtain the national baseline estimates.

Add data for all regions below

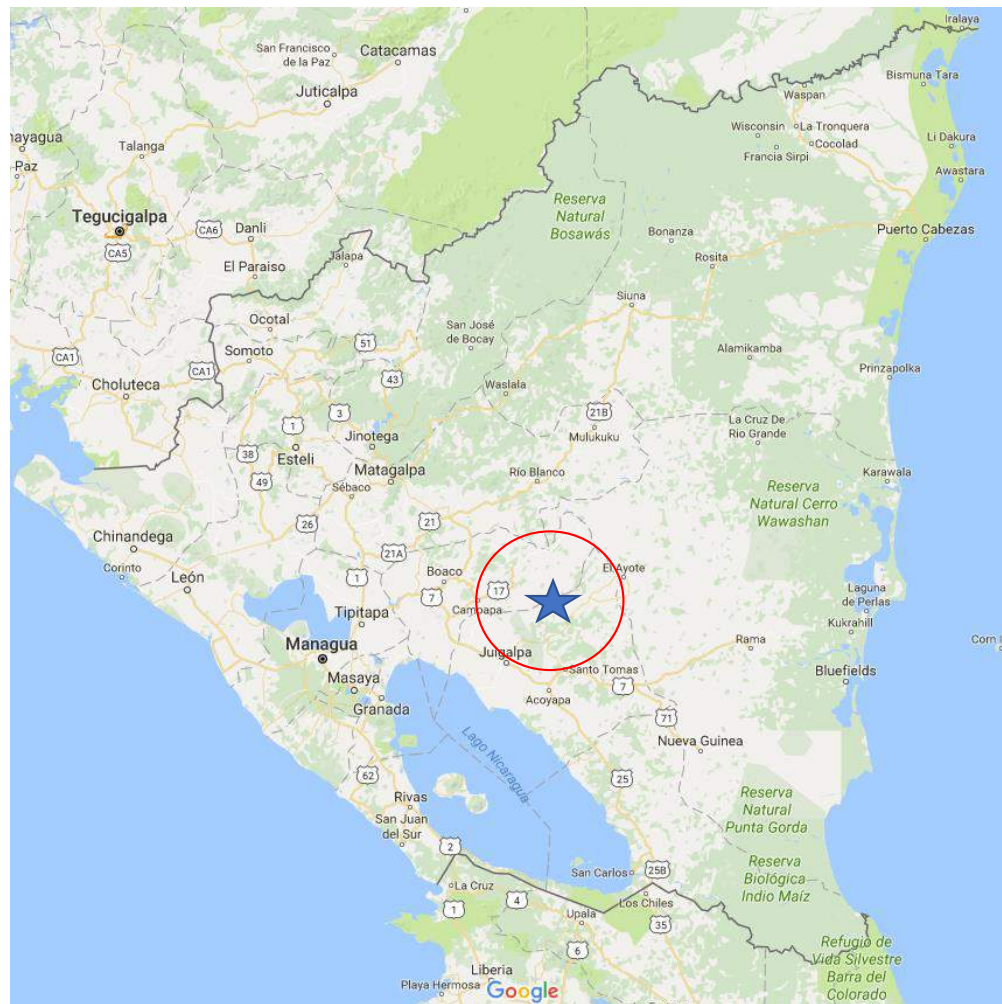
	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7	Region 8
	[Region Name]	[Region Name]	[Region Name]	[Region Name]	[Region Name]	[Region Name]	[Region Name]	[Region Name]
ASGM Gold Production (kg/y)								
ASGM Mercury Use (kg/y)								
ASGM workforce								

Step by Step Approach



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1. Visit Regional Stakeholders
2. Visit Mining Communities
3. Meet Authorities
4. Visit extraction / processing sites
5. Casual introductions
6. Observations
7. Worker Interviews
8. Other local interviews?
9. Revise and compile data daily
10. Site and regional estimates
11. Adjust as necessary!



Conclusions

- Various approaches and tools to collecting data
 - Select those appropriate for your methodology
- Constantly analyse information received
 - Both in the field, and afterwards
- Adapt methodology and questioning as you go
- Triangulate as often as possible
- Most important tool is knowledge of ASGM and experience



Other Reference Documents

1. Tools and Methods: Determining Mercury Use in the ASGM Sector

2. UNEP Nap Guidance Document

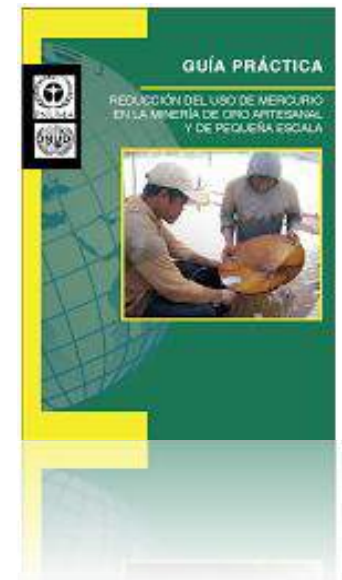
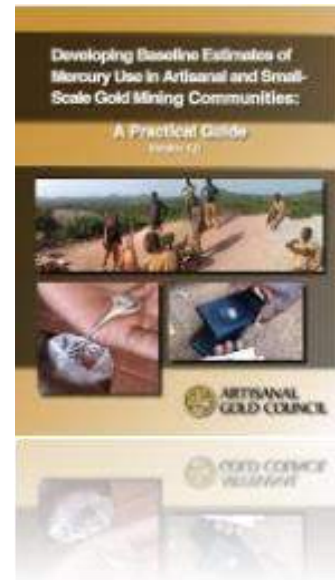
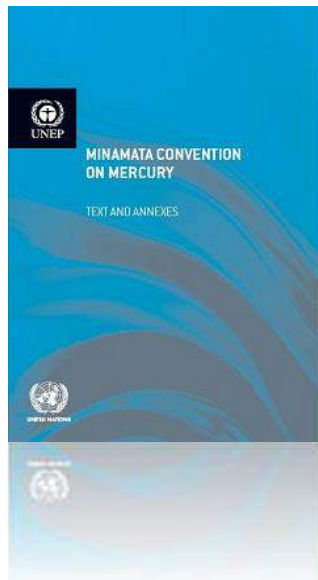
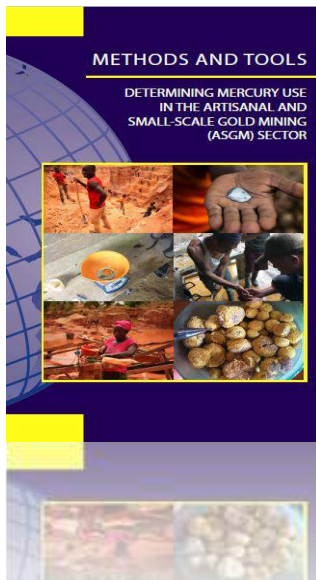
(<http://www.unep.org/chemicalsandwaste/global-mercury-partnership/asgm/national-action-plans>)

1. Minamata Convention on Mercury (UNEP)

2. Toolkit for Identification and Quantification of Mercury Releases (UNEP)

3. Developing Baseline Estimates of Mercury in ASGM Communities (AGC)

4. A Practical Guide: Reducing Mercury Use in ASGM (AGC/UNEP/UNIDO)





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Thank you very much!

Questions?



Extra slides

Correcting Impure Gold to 24K or 100% Pure Equivalence

$$\text{mass pure gold} = (\text{mass impure gold}) \times \frac{(\text{purity of impure gold})}{(\text{purity of pure gold})}$$

If the purity of your gold is stated in karats, the calculation will look like:

$$(\text{mass impure gold}) \times \frac{(\text{karatage impure gold})}{24}$$

If the purity of your gold is stated as percentage, the calculation will look like:

$$(\text{mass impure gold}) \times \frac{(\% \text{ purity of impure gold})}{100}$$

e.g.1. 50 g of 18K gold = (50 g) x (18/24) = 37.5 g of 24K gold

e.g.2. 70 g of 80% pure gold = (70 g) x (80/100) = 56 g of 100% pure gold

Gold Yield from Ore (Gold Production)

$$\text{gold yield} = (\text{mass ore}) \times (\text{recoverable ore grade})$$

e.g. 1. How much gold is yielded from 30 T of ore that has a recoverable grade of 5 g/T?

$$\text{gold yield} = 30 \text{ T} \times 5 \text{ g/T} = 150 \text{ g of gold}$$

e.g. 2. The average bag extracted by miners on site weighs 10 T. The recoverable ore grade is 6 g/T. How much gold is in each bag?

$$\text{gold yield per bag} = 10 \text{ T/bag} \times 6 \text{ g/T} = 60 \text{ g of gold per bag}$$

9.1.2. Mercury Calculations

Mercury recovery

Mercury-to-gold (Hg: Au) Ratio

See Section 6: Mercury-to-Gold (Hg: Au) Ratios.

9.1.3. Throughput Calculations

Sluice Throughput

$$\text{throughput rate} = (\text{width}) \times (\text{water depth}) \times (\text{water velocity})$$

$$\text{daily slurry throughput} = (\text{throughput rate}) \times (\text{hrs operating})$$

$$\text{daily ore throughput} = (\text{daily slurry throughput}) \times (\text{mass of sediment per m}^3 \text{ of slurry})$$

e.g.

Field officers measure the dimensions of a sluice and the velocity of the ore slurry passing through it. They interview the processors to find out how many hours per day the sluice is operating. They also fill a 1L soda bottle with the slurry enter the sluice and weigh it. They then drain the water out of the 1L bottle of slurry and weigh the sediment.

They find:

Sluice length = 14 m

Sluice width = 0.8 m

Water depth = 0.01 m

Water velocity = ~1.25 m/s

Hours operating = 20 hr/d

1 L slurry = 1285 g

Mass of sediment in 1L of slurry = 0.463 kg

What is the daily ore throughput of the sluice?

Throughput rate = $0.8 \text{ m} \times 0.01 \text{ m} \times 1.25 \text{ m/s} = 0.01 \text{ m}^3/\text{s}$

Daily slurry throughput = $20 \text{ hr/d} \times 3600 \text{ s/hr} \times 0.01 \text{ m}^3/\text{s} = 720 \text{ m}^3/\text{d}$

Daily ore throughput = $720 \text{ m}^3/\text{d} \times 463 \text{ kg/m}^3 = 333360 \text{ kg/d} = 333 \text{ T/d}$



9.1.4. Equations and Calculations for Processing Sites

Calculations per Each Processing System:

** important: each of these calculations is for one specific processing system type. Calculate this information for each system type (e.g., system 1 = sluice, system 2 = rastra, system 3 = panning).*

Daily 24K gold production (g/R/d)

Daily throughput (T/sys/d) x ore grade (g/T)

Correct karatage to 24K (as in Section 9.1.1.)

Daily mercury loss (g/R/d)

System-specific daily 24K-Au production (g/sys/d) x system Hg:Au ratio

Daily number of active processors (px/sys/d)

Shift count (px/shift) ÷ shift length (hrs/shift) x 24hrs

Daily active miners required to produce the daily throughput (ex/sys/d)

Daily throughput (T/sys/d) ÷ miner ore prod (T/ex/d)

Calculations for Site-level Daily Information

** once calculations are made for each type of processing system on the site, the averages for each processing system can be combined into site-level information.*

Daily 24K gold production (g/site/d)

Average of system type 1 daily 24K gold prod (g/sys1/d) x #sys1/site

Also calculate for system type 2, type 3, etc. and then sum production values for all system types.

Daily mercury loss (g/site/d)

Average of system type 1 daily Hg loss (g/sys1/d) x #sys1/site

Also calculate for system type 2, type 3, etc. and then sum production values for all system types.



Daily number of active processors (px/site/d)
Average system 1 daily number of active processors (px/sys1/d) x #sys1/site
Also calculate for system type 2, type 3, etc. and then sum production values for all system types.

Daily number of active miners (ex/site/d) – Option 1
Average system 1 daily active extractors (ex/sys1/d) x #sys1/site
Also calculate for system type 2, type 3, etc. and then sum production values for all system types.

Daily number of active miners (ex/site/d) – Option 2
Average site-level daily throughput (T/site/d) ÷ average miner ore production rate (T/ex/d)

Calculations for Regional-level Daily Information

Daily 24K gold production (g/region/d),
Daily number of active processors per region (px/region/d), and
Daily number of active miners per region (ex/region/d).
Extrapolation from site-level data using a known piece of regional information, e.g., number of processing systems in the region. (see Section 7.2: *Extrapolating Regional Estimates*).

Daily mercury loss (g/reg/d)
Daily 24K gold production (g/sys1/d) x (% of production yielded by system type 1) x (Hg:Au Ratio for system type 1)
Also calculate for system type 2, type 3, etc. and then sum production values for all system types.

Calculations for Regional-level Annual Information

Annual 24K gold production (g/site/yr)
Daily 24K gold production (g/region/d) x active days per year (d/yr)
Convert to kg/region/yr by dividing by 1000.

Annual mercury loss (g/site/yr), Option 1
Daily Hg loss (g/region/d) x active days per year (d/yr)
Convert to kg/region/yr by dividing by 1000.

Annual Hg loss (kg/site/yr), Option 2
Annual 24K gold production (kg/region/yr) x (% of production yielded by system type 1) x (Hg:Au Ratio for system type 1)
Also calculate for system type 2, type 3, etc. and then sum production values for all system types.

Annual number of active processors (px/region/yr)
assumed equal to the daily statistic

Annual number of active miners (ex/region/yr)
assumed equal to the daily statistic

Calculations for National-level Annual Information

Annual 24K gold production (kg/country/yr)
Sum all 24K gold production (kg/region/yr) for each of the major ASGM mining regions in the country

Annual mercury loss (kg/country/yr)
Sum all Hg loss (kg/region/yr) for each of the major ASGM mining regions in the country

Number of active processors (px/country)
assumed equal to the daily statistic

National active extractors (ex/country)
assumed equal to the daily statistic