

METHODS AND TOOLS

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



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environment



Lecture 4 ASGM Baseline Case Study: Nicaragua



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Case Study: Nicaragua

Introduction

- Overview of ASGM in Nicaragua
- National Level Scoping
- Developing a country specific methodology
- Methodology by mining region
- Data collection by region
- Data analysis by region
- Producing national estimates
- Conclusions

National Level Scoping

- Literature review
- Stakeholder Interviews
- Field visits to select regions
- Use existing information to develop a national approach



Literature Review

- Limited academic literature
- A few public sector reports (Government, NGOs)
- 3 major LSM companies (some useful information)
- Mining noted in 6 departments
- Basic understanding of extraction and processing



Stakeholder Meetings

Managua

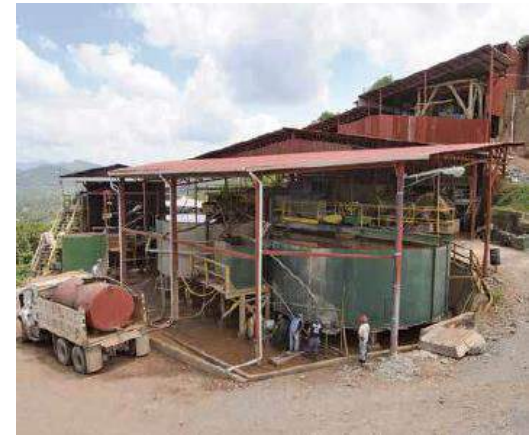
- National Governments (MEM and MARENA)
- NGOs operating in the sector
- LSM companies
- Gold buyers

Regional

- Regional and Municipal Governments
- Miners and Processors
- Gold Buyers

ASGM in Nicaragua

- ASGM present in 6 departments
- Few if any formal ASGM operations (local governance)
- Manual extraction, mechanised processing
- Extraction mixed open pit and tunnel
- ALL processing conducted using toll milling services
 - *Rastras, Ball Mills, Central Cyanidation*

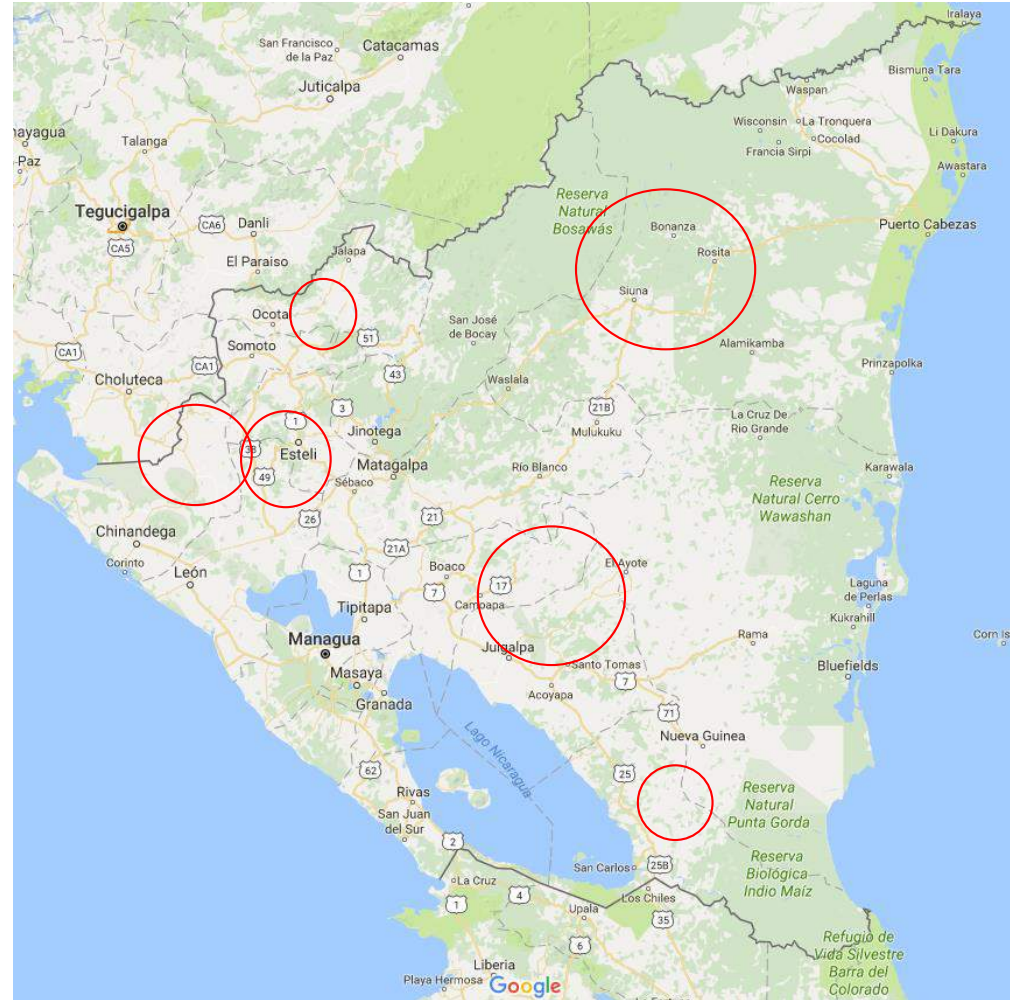


Rastras



Mining Regions

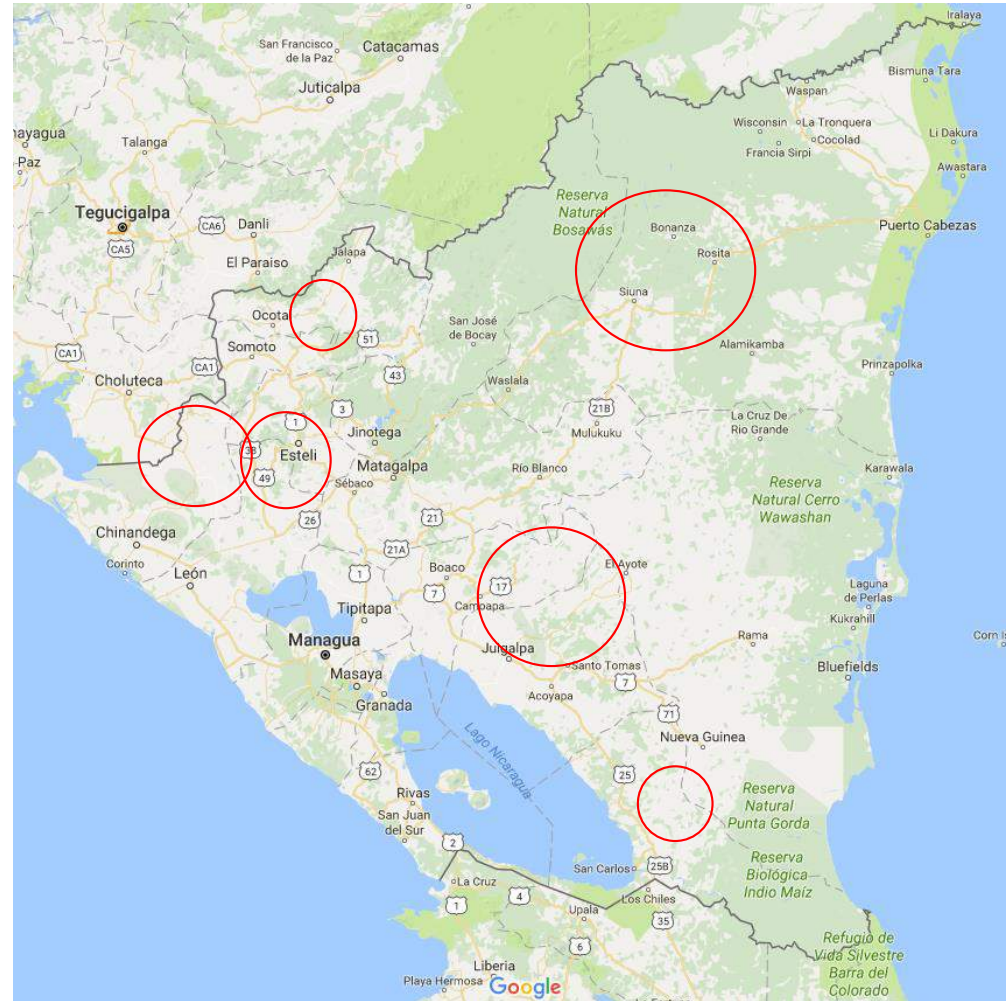
1. Chinandega
2. Bonanza Triangle
3. Chontales
4. Matagalpa, Esteli,
Leon
5. Nueva Segovia
6. Rio San Juan



Country Specific Approach

- Use existing information for each region, and couple with field data as needed
- Produce averages to allow extrapolation
- Sum regional averages to produce national estimates

Processing systems are key!

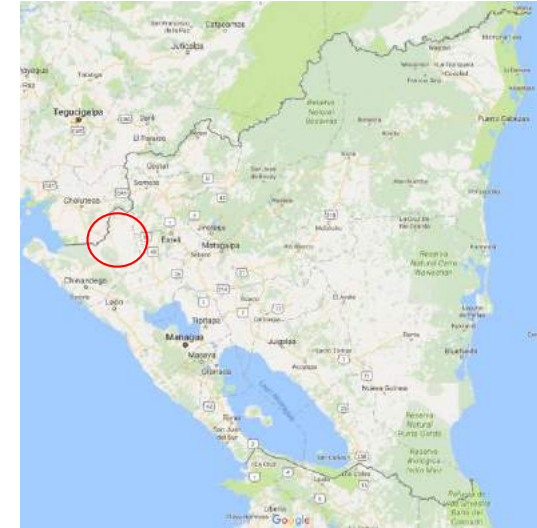


Chinandega Approach

- All processing done through rastras
- Regional MEM representative has recent count of active rastras

Plan:

- Determine regional averages, and apply to rastra count to produce regional estimates
 - Grade
 - Purity
 - Throughput
 - Days Active per year
 - Hg:Au ratio
- Go to field to collect regional data



Hg:Au Ratio Measure

Rastra 1 - Mercury input		
Time	Hg added (g)	Hg added (mL)
20:30	40.4	3
20:30	43.43	3
1:08	44.29	3
1:08	44.22	3
8:35	41.53	3
13:30	23.11	1.5
Total	236.98	16.5
Hg Recovered	206.25	
Hg Lost	30.73	

Rastra 2 - Mercury input		
Time	Hg added (g)	Hg added (mL)
20:33	40.81	3
20:33	42.02	3
1:05	43.59	3
1:05	44.32	3
8:40	33.08	2.5
13:30	31.07	2
Total	234.89	16.5
Hg Recovered	182.57	
Hg Lost	52.32	

Total Hg Lost	83.05
Total Au Produced 14k	12
Total Au 24 k	7
Hg:Au ratio	11.9:1

Hg:Au Ratio Measure

Total Ore Processed (T)	1
Initial Hg added	186.22
Recovered Hg	139.67
Hg Loss	46.55
Initial Amalgam weight	14.82
Amalgam % Gold	60 %
Total Gold produced (15 k)	8.860559306
Karat	15
Total Gold produced (24 k)	5.537849566
Ore Grade (g/T)	5.537849566
Price (USD)/g 24 k	37.9
SPOT USD	41.56
% Spot Received	91.19%
Hg:Au ratio	8.41:1

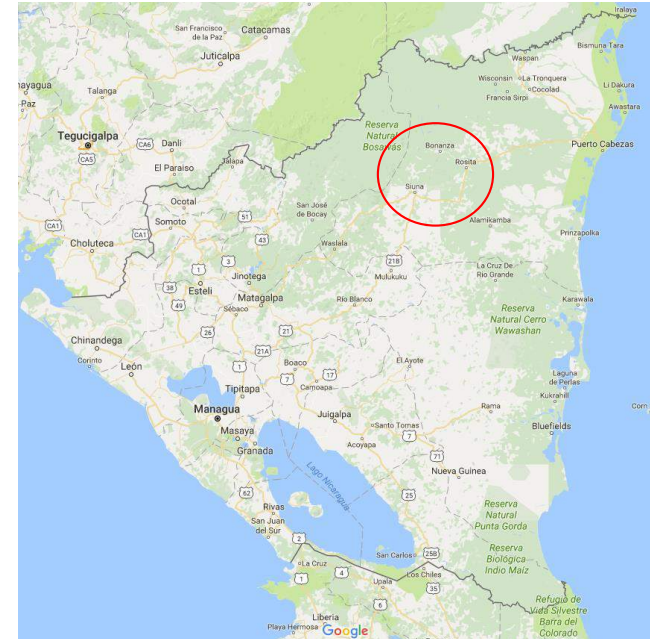
Chinandega

	Villa Nueva	Somotillo	Cinco Pinos	San Francisco del Norte	San Pedro	Santo Tomas	Departmental Total
Total # Rastras	339	63	8	9	5	5	429
# Rastras Operational	58	11	1	2	1	1	74
Troughput (T/d)	1	1	1	1	1	1	N/A
Grade (g/T 24K Au)	6.25	6.25	6.25	6.25	6.25	6.25	
Karatage	15	15	15	15	15	15	
Total Production 24 k (g/d)	362.5	68.75	6.25	12.5	6.25	6.25	462.5
Hg:Au ratio	8.4:1	8.4:1	8.4:1	8.4:1	8.4:1	8.4:1	8.4:1
Days active/year	300	300	300	300	300	300	300
Total Hg loss (year (Kg/yr)	913.5	173.25	15.75	31.5	15.75	15.75	1165.5
Total 24 K Au production (Kg/yr)	108.75	20.65	1.875	3.75	1.875	1.875	138.75
Total miners	638	121	11	22	11	11	814

- 3 workers / rastra
- 8 miners to produce 1 T ore

Bonanza Triangle

- Processing mixed rastras and ball mills
- 3 mining communities (Bonanza, Rosita, Siuna)
- Regional MEM representative had recent count of active rastras and ball mills for Bonanza
- Local consultants have count for Siuna / Rosita
- AGC did field visits to verify
- Determine regional averages, and apply to rastra and ball mill count to produce regional estimates



Bonanza Triangle

Bonanza



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Recoverable grade	6 g/T
Karatage	18 K
Days active/year	300
Hg: Au ratio (ball mill)	1:1
Hg: Au ratio (rastra)	8.4:1
Operators / ball mill	2 daily
Operators / rastra	3 daily
Miners/Tonne extracted	8

- Ball mill = 0.21 T/d

Siuna

	Ball Mill	Rastra	Totals
Active Mills	421	19	440
Total Daily Ore throughput	88.6 T	19 T	107.6 T
Daily 24 k Au production	531.6 g	114 g	527.24 g
Annual 24 k Au production	159.48 kg	34.2 kg	193.68 kg
Annual Hg use	159.48 kg	287.28 kg	446.76 kg
Operators	842	57	899
Miners	709	152	861
Workforce	1551	209	1760

	Ball Mill	Rastra	Totals
Active Mills	13	21	34
Total Daily Ore throughput	2.73 T	21 T	23.73 T
Daily 24 k Au production	16.38 g	126 g	142.38 g
Annual 24 k Au production	4.9 kg	37.8 kg	42.7 kg
Annual Hg use	4.9 kg	317.52 kg	322.42 kg
Operators	26	63	89
Miners	22	168	190
Workforce	48	231	279

Rosita

	Ball Mill	Rastra	Totals
Active Mills	10	4	14
Total Daily Ore throughput	2.1 T	4 T	6.1 T
Daily 24 k Au production	2.1 g	33.6 g	35.7 g
Annual 24 k Au production	0.630 kg	10.08 kg	10.71 kg
Annual Hg use	0.63 kg	84.67 kg	85.3 kg
Operators	20	12	89
Miners	17	32	190
Workforce	37	44	81

Bonanza Triangle

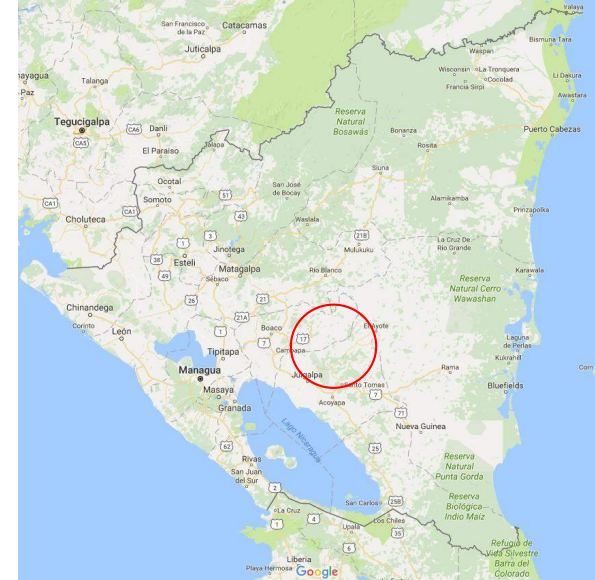
	Bonanza	Rosita	Siuna	Totals
Annual 24 k Au	193.68 kg	42.7 kg	10.71 kg	247.09 kg
Annual Hg loss	446.76 kg	322.42 kg	85.3 kg	854.48 kg
ASGM workforce	1760	279	81	2120

Chontales

- Reported rastra dominant processing workflow
- At national level no existing known counts

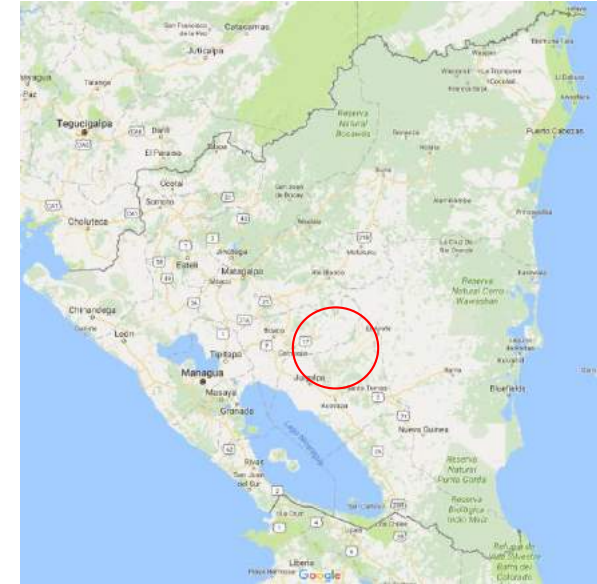
Plan:

- Visit site, conduct sit in (like Chinandega) to measure Hg:Au ratio
- Conduct interviews to collect local grade, throughput, karat, etc.
- Count all systems, produce estimates like before
- Reported Cyanide system buying ASGM ore
 - How does this impact inventory estimates?



Chontales

- Upon arrival conducted interviews with key stakeholders:
 - LSM company
 - Local municipality environment office
- Both Municipality and LSM company had rastra counts
- Rastras are different here!
- Use retorts!





Chontales - Data

	Site #	Worker/R/d	T/R/d	Grade (g/T)	Au Prod/Ras/d (g)	Karat	24 K Au/Ras/d (g)	Hg loss/day (g)	Hg: Au Ratio
La Libertad	S01	2.00	1.00	22.50	22.50	16.00	15.00	10.80	0.72
	S02	4.00	1.00	17.50	17.50	18.00	13.13	-	-
	S03	2.00	1.00	-	-	17.00	-	-	-
	-	4.00	1.00	12.00	12.00	15.50	7.75	-	-
	S05	4.00	1.00	20.00	20.00	15.00	12.50	-	-
Santo Domingo	S06	3.00	1.00	8.00	8.00	16.00	5.33	10.18	1.91
	S07	4.00	1.00	12.00	12.00	17.35	8.68	15.43	1.78
	S08	6.00	2.50	3.00	7.50	17.10	5.34	9.00	1.68
	S09	2.00	1.00	15.00	15.00	16.00	10.00	13.50	1.35
	S10	2.00	0.66	7.50	4.95	16.50	3.40	14.23	4.18
	S12	4.00	1.00	17.00	17.00	16.50	11.69	21.60	1.85
Averages		3.36	1.11	13.45	13.65	16.45	9.28	13.53	*1.55

Chontales - Comparisons

	AGC Estimates			Municipality Estimates			B2 Gold Estimates		
	LL	SD	Total	LL	SD	Total	LL	SD	Total
# Processing Sites	30	35	65	36	51	87	42	48	90
# Rastras	62	71	133	53	76	129	63	86	149
# Active Rastras	46	55	101	-	-	-	57	83	140
24 k Au / yr (kg)	132.66	154.82	287	-	-	-	102.60	149.40	252
Hg loss / yr (kg)	214.38	255.11	469	-	-	-	-	-	-
Ore Extraction (T/yr)	14640	18594	33234	-	-	-	17100	24900	42000
# Miners	195	248	443	-	-	-	228	332	560
# Processors	151	190	341	-	-	-	192	279	471
Total Workforce	347	438	784	-	-	-	420	611	1031

Plantel Los Angeles

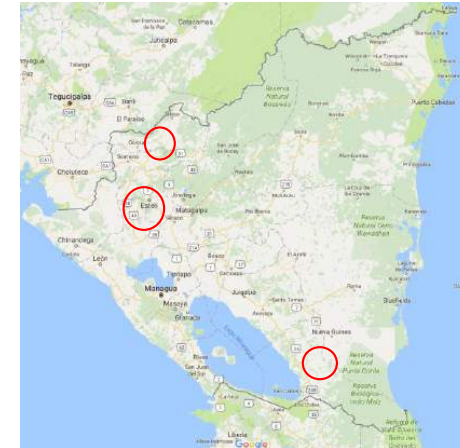
	Ore (T/d)	Ore (T/yr)	Ore Grade (g/T)	Au/d (g)	Au/yr (kg)	*Ore Production/miner (T)	# Miners
Los Angeles	120	43800	6	720	262.8	0.25	480

Chontales Totals

	La Libertad	Santo Domingo	Los Angeles	Total
24 k Au Produced (kg/yr)	132.66	154.82	262.8	550.28
Hg Loss (kg/yr)	214.38	255.11	-	469.50
Hg:Au ratio	1.55	1.55	-	1.55:1
Worker Population	347	438	480	1264

Other Regions

	Total Rastras	Operational Rastas	24 k Au (Kg/yr)	Hg:Au ratio	Total Hg loss (Kg/yr)	Total workforce
Leon	79	28	52.5	8.4:1	441	308
Matagalpa	11	11	20.6	8.4:1	173.25	121
Esteli	NA	NA	NA	8.4:1	NA	NA
TOTAL	90	39	73.1	8.4:1	614.25	429

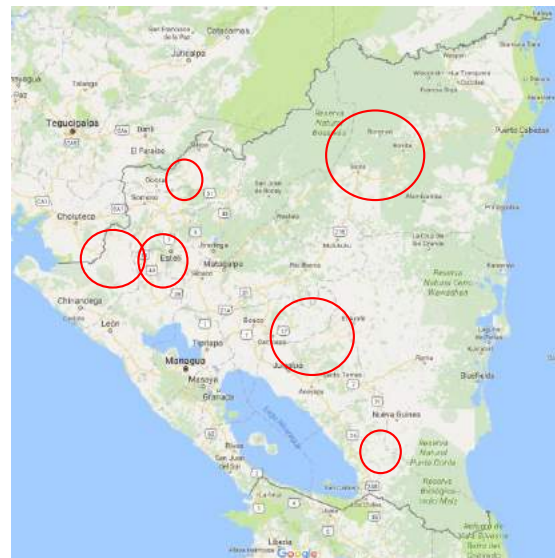


	Total Rastras	Operational Rastas	24 k Au Produced (Kg/yr)	Hg:Au ratio	Total Hg loss (Kg/yr)	Total miners
Nueva Segovia	14	14	26.25	8.41:1	220.5	154

	Total Rastras	Operational Rastas	24 k Au Produced (Kg/yr)	Hg:Au ratio	Total Hg loss (Kg/yr)	Total miners
Rio San Juan		6	11.25	8.41:1	94.5	66

National Estimates

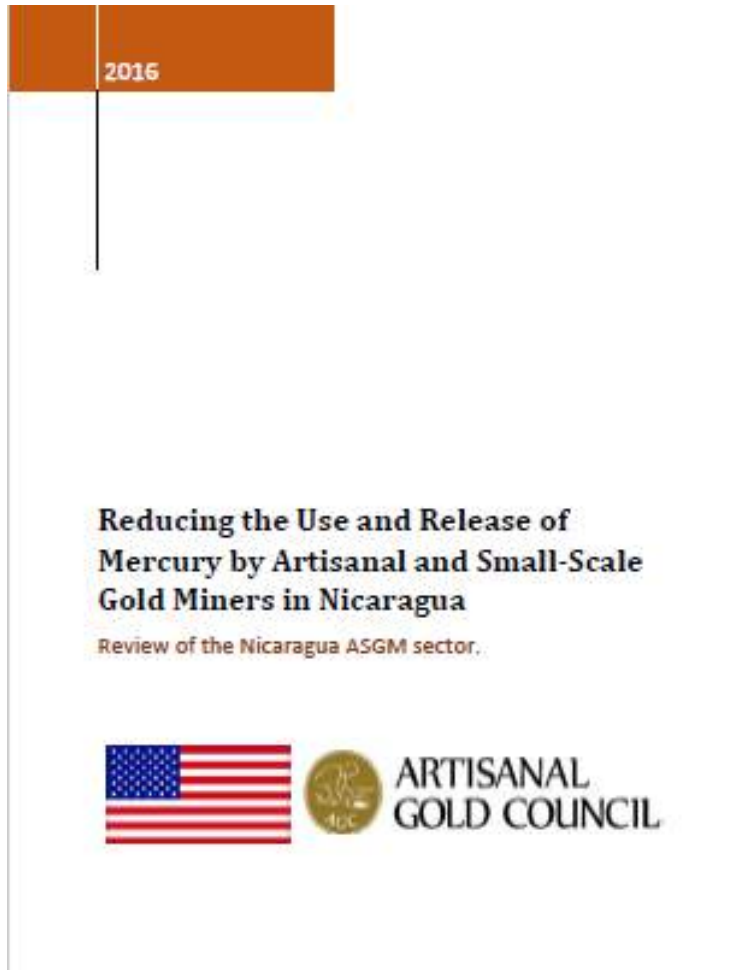
	Chontales	Chinandega	RAAN	León	Matagalpa	Nueva Segovia	Rio San Juan	Total
Au Production (kg/yr)	550	138.7	247.09	52.5	20.6	26.25	11.25	1046.4
Hg loss (kg/yr)	469	1165.5	854.48	441	173.5	220.5	94.5	3418.5
ASGM Workforce	1264	814	2120	308	121	154	66	4847



Conclusions

- National level scoping is key to methodology development
- On the ground realities may be different than expected (*Must adapt!*)
- Produce regional estimates however possible
- Sum regional estimates to produce national estimates

Additional Information



- Introduction to the Nicaraguan ASGM sector and additional inventory information:
<http://www.artisanalgold.org/publications/reports/>
- Another more detailed report on conducting inventory work in Chontales will be available soon.



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Thank you!

