

**ESTIMATION OF PRODUCTION,
TONS MINED AND TAILINGS
GENERATED BY THE SMALL-SCALE
GOLD MINING ACTIVITY**

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EXECUTIVE SUMMARY

Small scale gold mining in the Philippines has been practiced long before the colonization of the country by the Spaniards. Our country's history account that gold had been used in trading and the people from Cordillera had used this for decorative and self-adornment purposes.

The proliferation of small-scale gold mining/panning activity, which started in the early 80's, is considered as major contributor to the total gold production of the country. The continued increase in the price of gold and the pressure for alternative source of livelihood led to the proliferation of gold rush areas in the country, predominantly in Davao del Norte, Benguet and Camarines Norte.

This study was undertaken as part of the over-all effort of the National Statistical Coordination Board (NSCB) in developing the Philippine System of Economic and Environmental Accounting (PEENRA). Specifically, the objective of this study is to estimate the gold production, the amount of ore mined, and the tailings generated by small-scale gold mining. These variables are necessary inputs in estimating the physical asset account of small-scale gold mining and its degradation to the environment.

This study covered all the regions in the country. However, only detailed data for the year 1992 was available and utilized in the estimation. The results for the inclusive years 1988-1991 were calculated based on direct proportional relationship using the data from Central Bank.

The main source of data used in this study were the field reports and the consolidated summary for the year 1992 on small-scale gold mining gathered and retrieved from all the Regional Offices of the Mines and Geosciences Bureau (MGB), and the small-scale gold mining/panning map of the Philippines. Central Bank data on the amount of gold from small-scale miners was also utilized.

The information from these reports vis-à-vis the observations during actual visits/fieldworks were used as basis for the assumptions in the estimation process. Furthermore, the figures used were cross-checked and validated using the results of metallurgical laboratory testing studies on small-scale gold processing.

The estimation of gold produced by small-scale miners included that of gold panners, when applicable. In general, 360 calendar days was the factor used in the computation of the annual production for areas whose status of operation is known to be active and/or continuous. For panning activities and for those whose operation are seasonal and

intermittent, the factor 270 calendar days was used.

An assumption of 20% recovery of gold values from the ore mined was used in computing for the daily tonnage of ore as indicated from the results of studies and metallurgical laboratory tests conducted by the MGB. In general, the grade of the ore and the daily production from each location up to the level of barangays, which were retrieved from MGB Regional Offices field reports, were individually calculated and aggregated to come up with the estimation for the region as a whole. Computation for the annual tonnage adopted that of the annual production. However, for gold panning activities, a zero tonnage of ore mined was assumed.

The estimated total daily production and tons mined were obtained by summing up the daily production and tons mined, respectively, from each location up to the level of barangays and/or municipality.

In regions where data are insufficient or lacking, an assumed figure was used considering the factors such as the reported number of small-scale miner/panners, status of their operations, results of laboratory analysis on the assay of samples collected within the vicinity of the area concern, and on actual observations from areas whose situations and conditions prevailing are generally similar in nature.

In the estimation of tailings generated, a 40:60 solid to liquid ratio by weight was used and segregated from each other based on field observations and experiences during laboratory testing. The liquid portion, which is the amount of water used in the processing was presumed to form part of the tailings generated.

In all the estimation conducted, the two-product concentration process was adopted. This means that from the original ore mined/processed, two (2) products were produced: the gold values and the tailings. Due to the almost negligible weight of the gold values relative to the weight of the ore mined/processed, the weight of the ore mined/processed was considered to be the weight of the solid portion of the tailings.

However, not all the tailings generated by the small-scale miners goes to the environment. There are areas where the small-scale miners have constructed small impounding dams for their tailings. Others have either re-process the tailings themselves or sell it to interested large-scale mining companies. With these varied scenarios, it is difficult to estimate how much of the total tailings generated are impounded vis-à-vis that escapes to the environment.

From the results obtained, an estimated total of 7,773.33 kgs. of gold was produced for the year 1992. It would be interesting to note that the bulk of the production comes from the Cordillera Administrative Region (CAR), Region V (Bicol Region), and Region XI (Southern Mindanao) accounting for 80.36% of the total production. On the provincial level,

Davao del Norte has the highest contribution mainly due to the activity in Diwalwal.

The results in the calculation of tons mined shows that an estimated total of 1,158,591 metric tons (MT) of ore was mined/processed generating an estimated 2,896,727 MT of tailings.

While the over-all results showed that the major regions which contributed for the bulk of the total gold production also accounted for the bulk of the tons mined. It is imperative to note that this was brought about by the significant role of the average grade of the ore mined vis-à-vis the tons mined and eventual estimation of gold produced.

The percentage distribution for tons mined is also the same as the percentage distribution for tailings generated.

The yearly (1988-1991) estimation made use of the Central Bank data on gold coming from small-scale miners. Direct proportional relationship between the Central Bank data and the results of the 1992 estimation was adopted. In totality, an estimated 38,230.63 kgs. of gold was produced, 5.73 million MT of ore was mined, and 14.32 million MT of tailings was generated during the five- years period, 1988-1992.

Cautioned should however be exercised in using the results from 1988-1991 for these are merely a theoretical calculation. While there may be some other factors which may enhance the estimation procedure, data for these are not currently available. However, in the absence of other reliable and more accurate data, we can utilize the 1992 results with a relatively high degree of reliability and confidence.

In the light of this study, an updated detailed data on the small-scale gold mining activity should be gathered to come up with a more accurate estimation to date. The improved technology and sophisticated methods being utilized at present as well as the volatility of their activities and extent of operation should be factored in and considered in the estimation process. A detailed laboratory study replicating their present methods of processing should likewise be conducted to arrive at a more accurate and applicable figure on their actual recovery including that of the amount of ore mined and tailings generated.

These recommendations can initially be applied to those areas previously identified as major contributor to the total gold production, and the results from this study, particularly for the year 1992 can then serve as baseline data for reference.

I. INTRODUCTION

The proliferation of small-scale gold mining/panning activity, which started in the early 80's, is considered a major contributor to the total gold production of the country. However, it is widely believed that most of their production is unreported or not officially accounted. Most of the data available focus more on the estimated number of small scale miners and panners, which just gives us an idea on the extent of such activity in the given area or locality. This study was undertaken as part of the overall effort of the National Statistical Coordination Board (NSCB) in developing the Philippine System of Economic and Environmental Accounting (PEENRA).

Specifically, the purpose of this study is to estimate the gold production, the amount of ore mined, as well as the tailings generated by small-scale gold mining. These variables are necessary inputs in estimating the physical asset account of small-scale gold mining and in estimating its degradation to the environment. Likewise, those variables will establish the relative contribution of the regions/provinces to the total gold production from small-scale gold mining/panning.

II. BACKGROUND ON SMALL SCALE MINING

Small -scale gold mining in the Philippines has been practiced long before the colonization of the country by the Spaniards. Traders from other countries traded their goods with gold. The people of Cordillera had developed ways to mine and process gold for decorative and self-adornment purposes. Gold particles and nuggets were then panned from streams and rivers.

Prior to 1980, small-scale gold mining was just limited to intermittent alluvial gold placer mining. However, the continued increase in the price of gold and the increasing pressure for alternative source of livelihood spearheaded the proliferation of gold rush areas in the country. These are predominant in Davao del Norte, Benguet and Camarines Norte.

Notable developments in technology utilization were also undertaken. In the early 70's, the primary target was alluvial placer gold wherein recovery was mainly through direct panning or by crude sluice boxes. The shift to high grade veins utilized mining access through small and narrow passageway (dog holes). The ores were then manually pulverized with hammer, and the gold was recovered by panning with or without the use of mercury.

Eventually, the vein ores were accessed with larger and timbered adits, tunnels and stopes. The use of mechanized rod mills and more adequately line sluice boxes became prevalent, and more extensive use of amalgamation in the milling and panning stage. Recently, the use of 5-50 tons per day batch cyanidation plant utilizing carbon-in-pulp (CIP) process is being undertaken in several areas particularly in Diwalwal, Davao del Norte.

This phenomena of small-scale gold mining is expected to linger on for several more years. As far as the country is concerned, the principle is to recognize its existence and maximize the benefits derived from it with due consideration to sustainable development and the environment.

III. SCOPE AND COVERAGE

This activity is focused on the estimation of gold produced by small-scale gold miners (including that of gold panners where such activity is reported or are widely known), the tonnage of ore mined, and the tailings eventually generated. All the regions in the country were covered in this study.

However, only the detailed data for the year 1992 was available and utilized in the estimation. The results reflected for the other years (1988-1991) were calculated based on direct proportional relationship using the data from the Central Bank.

IV. SOURCES OF DATA

The main source of data used in this study were field reports and the consolidated summary for the year 1992 on small scale gold mining gathered and retrieved from all the Regional Offices of the Mines and Geosciences Bureau (MGB), and the small scale gold mining/panning map of the Philippines. This consolidated and summarized data together with the map contains the following information: a) location; b) estimated assay or grade of the ore mined; c) status of operation; d) number of miners/panners; and e) the estimated daily gold production. Central Bank annual data on the amount of gold from small scale miners was also utilized.

These information coupled with actual site visit/observation were the bases for the assumptions used in the estimation process. The figures used were cross-checked and validated using the results of past studies on small-scale gold processing.

V. ESTIMATION METHODOLOGY

The estimation of gold produced by small-scale miners, as mentioned earlier, included that of gold panners, where applicable. In general, 360 calendar days was the factor used for the computation of the estimated annual production/annual data in areas whose status were known to be active and with continuous operation. However, for panning activities and for those whose operation are seasonal and intermittent, only 270 calendar days was considered for the year. In essence, the formula used was:

$$(1) \text{ Estimated annual production} = \text{Estimated daily production} * 360$$

(for active areas with continuous operation)

or

$$\text{Estimated annual production} = \text{Estimated daily production} * 270$$

(for panning activities, seasonal, and intermittent operation)

An assumption of 20% recovery of gold values from the ore mined was basically used in computing for the daily tonnage of ore. This was the general average of recovery by small scale miners as determined by the results of past studies and metallurgical laboratory tests conducted by the MGB. The general formula adopted is:

$$(2) C = B/A(0.2) = 5B/A$$

where:

A = grade of ore in gmsAu/MT

B = daily production in gmsAu

C = tons mined per day

In general, data for A and B were retrieved from the MGB Regional Offices consolidated and summarized reports and/or fieldwork reports. The given data from each location, up to the level of barangays, were individually calculated and aggregated to eventually come up with the estimation for the region as a whole.

Computation for the annual tonnage adopted that of the annual production as discussed earlier. However, due to the nature of gold panning activities, a zero tonnage was assumed.

The computed average grade of the ore mined for the Regions and Provinces were derived by using the formula:

$$(3) D = 5E / F$$

where:

E = total estimated daily production in gms.

F = total estimated daily tons mined in MT

D = average grade for the Region/Province in gms. Au/MT

Estimated total daily production (E) and estimated total daily tons mined (F) were obtained by summing up the daily production and tons mined from each location up to the level of barangay and/or municipality. On the other hand, the average grade of the ore for the region/province was derived by dividing the total gold values in the ore in gms. Au by the total weight of the ore in metric tons (MT).

In regions where no data is available on the grade of ore or daily production, an assumed but practical and realistic figure was used in the calculation. Factors considered in coming up with the assumed figure are the reported number of small scale miners/panners, status of their operations, and results of laboratory analysis on the assay of samples collected within the vicinity of the area of concern, if any. There are also cases when a conservative figure was used based mainly on actual observations and/or results of analysis from areas where situations and conditions prevailing are generally similar in nature.

In the estimation of the tailings generated, the solid and liquid portion were segregated from each other. A 40:60 solid to liquid ratio by weight was used. This was based on the field observation and actual experience during laboratory testing. The liquid portion is the amount of water used in the processing. Since gold processing by small-scale miners is not a closed system, it was presumed that all the water used forms part of the tailings generated.

In all the estimation process, the two product concentration process was adopted. This means that from the original ore mined/processed, only two (2) products were produced: the gold values and the tailings. However, due to the almost negligible amount of gold values relative to the mined ore by weight, the weight of the mined ore was considered to be also the weight of the solid portion of the tailings.

Let it be clarified, however, that not all tailings generated by the small-scale miners goes to the environment. In some cases, like in Camarines Norte and Diwalwal, Davao del Norte, they have constructed small impounding dams for their tailings. On the other hand,

small-scale miners in Benguet area have either re-process the tailings themselves or sell it to interested large-scale mining companies. With these different scenarios, it is difficult to estimate how much of the total tailings generated are impounded vis-a-vis that goes to the environment.

As mentioned earlier, only the year 1992 data was available in coming up with the above mentioned estimation. For purposes of theoretical calculation for the years 1988 to 1991, Central Bank data on gold coming from small scale miners were used to estimate the gold production, tons mined and tailings generated vis-à-vis the 1992 estimation results. This Central Bank gold production data were assumed to be inclusive of those from small-scale mining and gold panning activities. All gold sold to CB is in bullion form and no distinction can be made whether such came from small-scale mining or purely panning activity.

VI. RESULTS AND DISCUSSION

From the results obtained (Table 1), an estimated total of 7,773.33 kgs. of gold was produced from small scale gold mining and panning activities all over the Philippines for the year 1992. It can be noted that the bulk comes from the Cordillera Administrative Region (CAR) recorded at 32.89%, Region V (Bicol Region) for 15.90% and Region XI (Southern Mindanao) for 31.57%, accounting for 80.36% of the total production. A relatively substantial amount also comes from Region X (Northern Mindanao) which accounts for 9.29% while the remaining regions contributed 10.35% of the total production (Table 3). The provinces of Benguet and Kalinga-Apayao in Region CAR, Camarines Norte in Region V, Agusan del Sur in Region X, and Davao del Norte in Region XI are the major sources of the gold production in their region with Davao del Norte having the highest contribution mainly due to the activity in Diwalwal.

The results in the calculation of the tons mined (Table 1) shows that an estimated total of 1,158,691 MT of ore was mined/processed generating an estimated 2,896,727 MT of tailings (liquid and solid combined). It is worth noting that the reported/estimated production for Regions I and III and the provinces of Ifugao, Camrines Sur, Misamis Oriental, Bohol, Rizal and Quezon, all come from panning activities, hence, a zero estimated tonnage of ore mined and consequently a zero tailings generated.

In general, it is expected that the major contributor to the gold production will account for the highest tonnage of ore mined. However, a relative comparison between Regions CAR and Region XI paints a different picture (Table 3). While their relative contribution to the total gold production is almost equal, their relative tons mined are far different with CAR accounting for 56.89% and Region XI accounts only for 17.79%. This is mainly due to the average assay of the ore in the two (2) regions which are 18.35 gmsAu/MT for CAR and 59.12 gms Au/MT for Region XI. This case highlights the significant role of the average grade of ore mined vis-a-vis the tons mined and eventual estimation of gold produced.

The major regions (CAR, V, X and XI) which contributed for the bulk of total gold production, also accounted for the bulk of the tons mined estimated at 87.41% of the total. The rest of the regions accounted for the balance of 12.59%.

The percentage (%) distribution for tons mined (Table 3) is also the same for the percentage (%) distribution for tailings generated.

The yearly calculated estimation of small scale gold mining production, tons mined and tailings generated were derived at using the Central Bank data on gold coming from small-scale miners. Direct proportional relationship between the Central Bank data and the results of the 1992 estimation was adopted in the calculation (Table 4). In summary, during

the inclusive period 1988 to 1992, an estimated 38,230.63 kgs. of gold was produced, 5.73 million MT of ore was mined, and 14.32 million MT of tailings was generated.

Caution should however be exercised in using these figures (1988-1991) for these are merely a theoretical calculation for the purpose of coming up with a rough estimation and a general scenario of the extent of their operation. The 1992 data and results even indicates that 95.87% of the total production was sold to Central Bank, which in general, is believed to be too high. While there may be some other factors which may enhance the estimation procedure, data for these are not currently available. Suffice it to say in the absence of other reliable and more accurate data, we can utilize the 1992 results with a relatively high degree of reliability and confidence.

VII. RECOMMENDATION

In the light of this study, the following recommendations should be considered in order to improve the estimation procedure for small scale gold mining.

An updated detailed data on the small-scale gold mining activity should be gathered to come up with a more accurate estimation to date. Conditions prevailing during the covered years in this study have significantly changed with the improved technology and more sophisticated methods being utilized at present by the small-scale miners. The volatility of their activities by nature and extent of their operations should also be factored in and considered in the process of estimation. Actual sampling and analysis of ore mined/processed should also be made the basis in determining the average grade of the ore.

A detailed laboratory study replicating their present methods of processing should also be conducted to come up with a more accurate and applicable figure on their actual recovery including that of the amount of ore mined and tailings generated.

Since we have at least identified the regions and provinces which are the major contributor to the total gold production, the above recommendations can be initially applied to these localities. The results from this study, particularly for the year 1992, can then serve as the baseline data for reference.

REFERENCES

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ACRONYMS

NSCB - National Statistical Coordination Board

PEENRA - Philippine System of Economic and Environmental Accounting

CIP - Carbon-in-Pulp

CB - Central Bank

MGB - Mines and Geosciences Bureau

CAR - Cordillera Administrative Region

MT - Metric Ton

Au - Gold

Kgs. - Kilograms

Gms. - Grams

DEFINITION OF TERMS

Small-Scale Mining - involves the operation of a single unit mining operation having an annual production not exceeding 50,000 metric tons of run-of mine ore with the following requisites: (1) the working is artisanal, either open cast or shallow underground mining, without the use of sophisticated mining equipment; (2) minimal investment on infrastructures and processing plant; and (3) Heavy reliance on manual labor.

Gold Panning or Sluicing - means any gold mining operation having a daily production output of not more than five (5) metric tons of ores which shall not involve highly mechanized method but only man labor by panning or sluice box.

Panning - means the recovery of gold by the use of dishpan-like wood, metal or any material through the skillful manipulation or control of human hands.

Sluicing - means the recovery of gold by using sluice boxes.

Tailings - waste products that are generated during the recovery of mineral commodities from their ores or other sources.