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Analysis of Labor Exploitation in the Mining Industry

Team Accuterians

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ABSTRACT

Our study primarily focuses on examining known labor exploitation in the production of various mined minerals worldwide. Utilizing datasets obtained from public sources, we examined various commodities, their manufacturing origins, and the known presence of child or forced labor. Our analysis revealed that forced labor and child labor persist in numerous countries worldwide, with coal, gold, and copper mining production being significant contributors. Furthermore, a substantial portion of these commodities are directly sourced from countries implicated in non-compliance or minimal compliance with minimum standards for eliminating trafficking. Our paper delves deeper into these findings, offering valuable insights and proposing measures to address and monitor such issues.

INTRODUCTION

Today, more than 27 million people, including 3.3 million children, are in situations of forced labor worldwide and the number is growing [1]. As global supply chains become longer, more complex, and raw materials are increasingly sourced from many small operations, there is increased risk of labor exploitation [2]. However, incidents of forced labor and child labor remain hard to detect, track, and regulate.

World governments and agencies have established standards to address the issues of trafficking in persons, including the United States (US) Trafficking Victims Protection Act of 2000 (TVPA), and international conventions of the United Nations (UN) Human Rights Office and UN International Labor Organization. The US Department of State releases annual lists of countries that do and do not comply with the TVPA minimum standards for the elimination of trafficking. We used these country rankings, called tier numbers, in our analysis.

We focused on the forced labor and child labor in the mining sub-sector of the manufacturing industry because it is one of the world's most hazardous sectors, especially for children. Mining is considered by Human Rights Watch to be one of "the worst forms of child labor", due to exposure to toxic chemicals like mercury in gold mining, increased injury risks from lifting heavy rocks and using sharp tools, and even death from mine shaft collapses [3]. The use of exploited labor spans the mining industry, including reports of child labor used in 29 mine-produced goods across 34 countries [4].

The analysis focused on countries with a high tier number and mined goods with known forced or child labor occurrences. We sought to further understand the dynamics of mined materials at the source, from the mining location, as forced labor occurs most frequently at the lowest levels of global supply chains [1].

DATA SOURCES

We used four public data sources: A list of commodities produced by forced or child labor (from two different sources), locations and production amounts for mines worldwide, and Trafficking in Persons Reports country-specific tier numbers. Only two data sources were in tabular format and the remainder we converted using manual processing.

We combined two datasets on forced labor and child labor across countries and commodities. The first dataset is from the 2022 list of products produced by forced or indentured child labor from the US Department of Labor (US-DOL) [5]. The second source is from Verité, a fair labor non-profit organization, that created a similar list to US-DOL [2].

A database listing coal and metal ore extraction locations and production worldwide from 2000-2021, and containing over 1,000 individual mines from 80 countries was a primary data source for analysis [6]. A consortium of researchers created the dataset through a tedious manual processing of publicly available source documents. However, not all mining data and production information is available publicly, and therefore, the dataset is not comprehensive of all mining worldwide but remains a great attempt at understanding distribution and production amounts across many mined minerals.

The last data source is the tier number of countries worldwide with these assigned values: Tier 1, Tier 2, Tier 2 Watch List, and Tier 3. The US Department of State annually assesses and assigns a tier number based on whether the country is meeting the minimum standards for eliminating trafficking (Tier 1), not fully complying (Tier 2), requires special scrutiny due to increased trafficking (Tier 2 Watch List), or does not comply nor making efforts to do so (Tier 3) [7].

PROBLEM STATEMENT

There remains little information about child labor and forced labor in the mining industry. Through our research, we addressed the following questions:

- Which mined commodities are known to use forced labor, child labor, or both?
- How are Tier levels related to known forced labor and child labor occurrences within mined commodities?
- We know the amount of mined material produced from mine locations in our dataset, can we find commodities with a disproportionate production volume that are also known to use exploited labor in that country?

DATA PROCESSING

We used SAS® Viya® 3.5 SAS Studio for joining data and Visual Analytics for data analysis. Numerous joins were required due to our multiple disparate datasets. We used SAS Studio to join these data (Figure 1, Appendix).

Our SAS Viya 3.5 licensing does not include ArcGIS integration for georeferencing data from a different format. Therefore, we converted the gpkg data in ArcGIS® Pro [8] and created a new table with latitudes and longitudes which was joined to the primary dataset.

Once the data were joined and ready for analysis, we created a geographic item using the country name. However, not all countries were mapped successfully using the built-in geographic country lookup in SAS Viya. We realized that some countries have specific naming conventions required for auto-matching, and used SAS Support's *Geographical Lookup Values for SAS Visual Analytics* to find the correct country name, resulting in a 100% match [9].

ANALYSIS

We focused on extracting meaningful insights from our data using the Explore and Visualize tool of Visual Analytics in SAS Viya. We began by adding additional fields to the analysis. For example, child labor and forced labor were two separate columns, and we created a new calculated data item called CLFL_value using an if-else condition to check for the value in both columns, resulting in the values: CL, FL, Both or None. This allowed us to properly understand which countries had only child labor, only forced labor, both, or none.

If a country has known accounts of forced labor or child labor for a particular commodity we categorized the countries from which the commodities are produced as Safe and Not Safe; Safe means child labor and/or forced labor are not known to be in the manufacturing of the commodity and the vice versa for Not Safe. We created a new calculated data item, Safe/Not Safe by adding an if-else condition to check for child or forced labor. This showed which commodities are produced from countries having child labor and/or forced labor.

Since the dataset had the list of countries showing the commodities produced, we created a series of geo maps to provide better insights about the data. We created regional geo maps to analyze country tier number distribution, and Safe/Not Safe country distribution by commodity, as well as a coordinates geo map showing mining locations (using the latitude and longitude data) to see the distributions of mines for a particular commodity, especially in countries where child labor or forced labor are prevalent.

FINDINGS

We observed that coal, copper, and gold were commodities with the highest number of mines in countries categorized as Not Safe for the given commodity. As a result, we opted to focus the analysis on only these three commodities.

Figure 2 (Appendix) is a geo map showing all countries in our dataset producing coal, gold, copper and the distribution of child labor (CL), forced labor (FL), both, or none (CLFL_value) across these countries. Even while it was encouraging to see that exploited labor might be rare from our limited datasets, it was startling to learn that child and forced labor is still common in some nations whose commodity production have a significant impact on the economy, as some are large producers of the commodity. Our curiosity about this type of work in these nations was piqued by this.

We also evaluated the tier values for the countries in our dataset. The geo map (Figure 3, Appendix) displays countries categorized by tier level. Notably, Tier 3 classification appears exclusively in China, while Tier 2 Watch List designation is primarily evident across major regions of Africa. Upon closer examination, our analysis reveals that forced labor is more prevalent in China than child labor for the analyzed commodities, with this issue persisting since 1964. China's designation was Tier 2 since 2000 but degraded to a Tier 3 in 2013, and consistently merits a Tier 3 rating without improvement. Similarly, Africa continues to maintain its Tier 2 Watch List status from previous years. The absence of progress in addressing these labor conditions over the past five decades in these countries is alarming.

COAL

Among the three commodities, coal has the highest child labor and/or forced labor (Not Safe) country count percentage (5 countries of 15 producing countries, 33%), see Figure 4 and Table 1 (Appendix). We also see that China is the second largest producer of coal and the production is known to use forced labor. On further analyzing the mines' latitudes and longitudes, we discovered that the major mines in China are skewed in the Inner Mongolia region which is famous for its coal rich land. We have seen Inner Mongolia struggling with forced labor, human trafficking and child labor in the past. Though in 2022, Mongolia made moderate advancement in the efforts to eliminate the worst forms of child labor [10].

As we can see from Table 1 (Appendix), just 13.9% of all coal mines worldwide are located in Not Safe countries, while 41.4% (37B value tons with total production being 89B) of coal generated comes from Not Safe nations (Figure 4, Table 1, Appendix). This is extremely concerning because these Not Safe nations produce the bulk of the world's coal. China is the second largest producing country in the world for coal with value tons of 18B (21% of total world production, 51% of total Not Safe production), is followed by India with the value tons of 15B (17% of total world production, 41.3% of total Not Safe production) and both countries using forced labor; India being in Tier 2 and China still being at Tier 3 status.

GOLD

When it comes to gold, 30.9% of the supply (5M value tons) originates from Not Safe nations, whereas they only represent 11.2% of the mines worldwide, which is highly disproportionate (Table 1, Appendix). Child labor is more common in the gold mining industry than forced labor. The hazardous and labor-intensive nature of gold mining is made worse by the unpredictability of the industry and the long hours worked. Considering these circumstances, we can state that involving children in these activities might frequently put their lives in danger.

COPPER

Lastly, for copper only two of 25 nations, accounting for 5% (9M value tons) of worldwide production is from Not Safe countries whereas the countries represent 16% of the mines locations (Figure 4, Table 1, Appendix). For copper both child labor and forced labor are prevalent. These numbers may not sound big when compared to coal and gold but it is necessary to note for copper both kinds of labor are prevalent and it is always better to highlight these kinds of activities to enhance prevention.

CONCLUSION

The analysis shows that there are three major commodities, coal, copper and gold, suffering from unethical production due to child labor, forced labor, or both types, with coal being the most alarming with the CLFL frequency way higher than any other commodity.

Based on our findings, it is evident that countries such as China (classified as Tier 3) and India (classified as Tier 2), which rank among the top two coal producers globally, must enhance their operational practices. Despite efforts to close numerous illegal mines in Inner Mongolia, a significant coal-producing region in China, the situation has not markedly improved, and China remains categorized as Tier 3.

Furthermore, within gold production, there are a total of 12 countries engaged in questionable practices. Peru and Indonesia are the primary contributors to gold production among these 12 countries, accounting for 33.5% and 31.5%, respectively, of the total output. This collective output from the 12 countries represents approximately 31% of the total gold production. Given this substantial contribution, it is imperative that countries in Tier 2 status, such as these, should not be considered acceptable.

Such cases and not just for coal, copper and gold but for all the commodities should be taken seriously and world organizations should continue to step forward to create awareness of these issues. In addition, it is critical that these organizations monitor the areas around these mines, particularly those where child or forced labor is prevalent. In order to reduce the likelihood of such scenarios, it is crucial to ensure that every area of the world is thoroughly examined.

Taking China as an instance, it’s evident that there has been little to no improvement in the situation since 1964 which is almost five decades now. It is crucial to have a more robust mechanism to keep a check on the progress of these kind of situations. Continued analysis

should be done regularly to find such pain points and if there has been no improvement as in China, then delving deeper into the root cause should be the next step.

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CONTACT INFORMATION

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APPENDIX

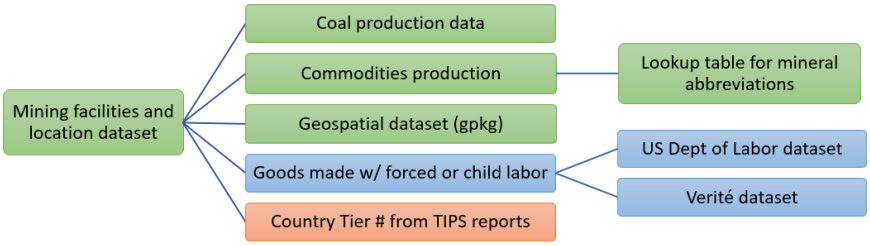

Figure 1. Data joins using nine separate datasets representing different data categories (i.e., mining, forced labor, tier) from multiple sources, by color.

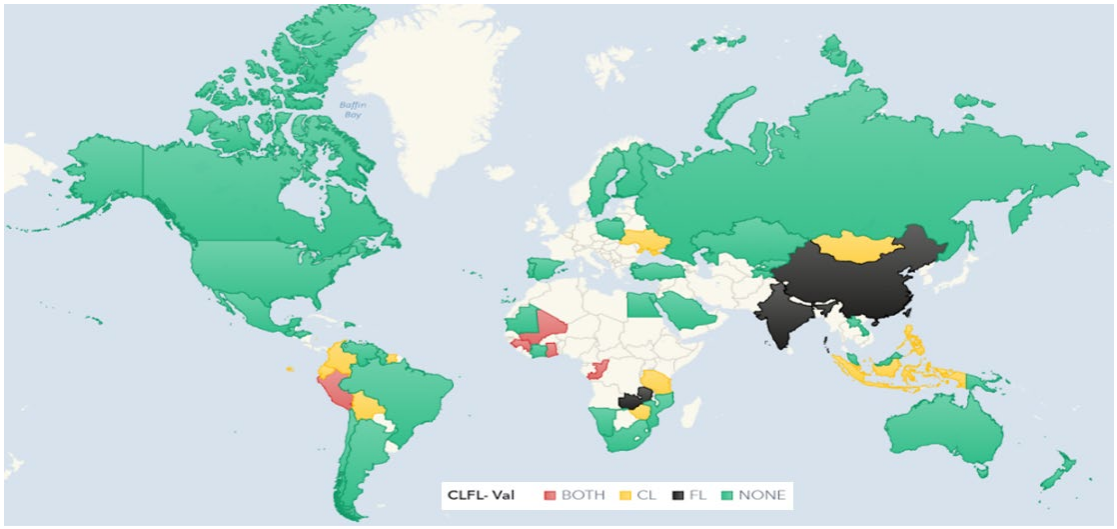

Figure 2. Regional geo map showing the distribution of child labor (CL), forced labor (FL), both, or none for coal, copper and gold.

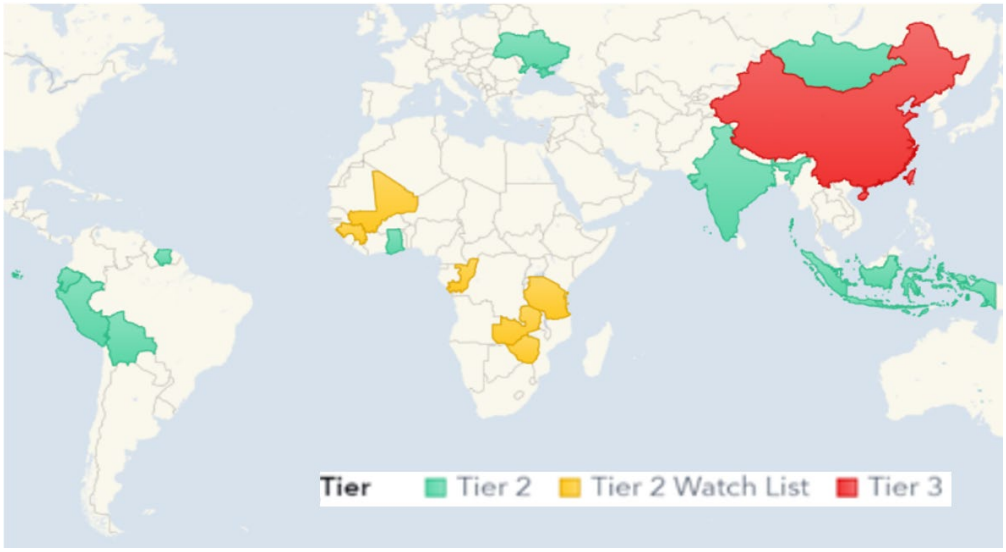

Figure 3. Distribution of Tiers across various countries for coal, copper and gold.

Figure 4. Distribution of coal, gold and copper of production across safe and non-safe countries.

Primary Commodity	# Countries Not Safe vs. Safe	Total Production from Not Safe	Total Mines from Not Safe	Major Contributing Countries (% of Not Safe production)
Coal	5 vs. 10	41.4%	13.9%	China (51%) India (41.3%)
Gold	12 vs. 26	30.9%	11.2%	Peru (33.5%) Indonesia (31.5%)
Copper	2 vs. 25	5%	16%	Zambia (53.1%) Congo (46.9%)

Table 1. Crosstab showing count of Safe and Not Safe countries, percentage of total production percentage from Not Safe countries, total percentage of mines from Not Safe countries, and the percent contribution of Not Safe production to total production for coal, gold, and copper.