The Artisanal and Small-Scale Gold Mining (ASGM) represents 20% of the total gold supply, constituting an important activity for the global economy, and especially for the local communities involved in the extraction and processing of gold and their clients downstream in the value chain. Taking into consideration its importance, and the need to include climate, biodiversity and water considerations in every business decision, the Swiss Better Gold Initiative (SBGI) conducted this LCA study to provide a better understanding of the ASGM's interrelationship with three fundamental components of any climate decision: the CO2eq emissions, biodiversity, and water.

This study was conducted in five ASGM mines, three located in Colombia and two in Peru. These were selected based on the different mine typologies with which SBGI collaborates to improve the environmental and social conditions of the gold supply chain, and they constitute a relevant sample of the SBG-value chains. Staff interviews, data collection, and analysis of the processes were documented during site visits, allowing for the creation of an inventory of the energy, water, and materials consumed in the mining operations during 2021. This inventory is the backbone of three separate studies that were conducted in parallel with different methodologies, based on climate, biodiversity, and water approaches.

The first part of the report focuses on the impact on climate. Therefore, the selected methodology was Product Carbon Footprint (PCF), following the ISO 14067 guidelines. The goal is to compare the number of kilograms of CO2eq emissions released while producing one kilogram of gold of 99% purity across the mines. The greenhouse gas (GHG) accounting covers primary emissions sources during mineral extraction, mineral processing, transportation of the materials needed for the mining operations, transportation of the final mined product to a refinery in Switzerland, and the final refinement of gold. Finally, the results were used to understand Scope 1, 2, and 3 emissions according to the GHG Protocol methodology. The SBG study concludes that total emissions results are highly variable, with an average of 38.096 kgCO2eq/kg of pure gold. The high variability of the results depends on a set of factors, including the type of mine (open pit or underground), how the gold is presented in nature (alluvial or gold vein), the gold concentration and purity, the geographical location, and the type of technology used during production. There are several interventions that represent a potential opportunity to reduce GHG emissions, depending on each mine's characteristics. In general, the five mines would see their emissions considerably reduced by deploying solar and wind projects and using biofuels and hydrogen.

The second part of the report analyzes the impact of 1 kg of mined gold on the effects of the ecosystem health, and therefore biodiversity. The ecosystem health is highly impacted by soil acidification in underground mines, while land stress is particularly impactful in open pit mines. The final results are rendered in two widely adopted biodiversity metrics: The Potential Disappeared Fraction of Species (PDF) and the Mean Species Abundance (MSA). The PDF measures the percentage of species that could be extinct in a year due to environmental pressures. The MSA analyzes the relative abundance of species in a pristine environment with no anthropogenic interventions. The PDF and MSA indicators allowed for comparison of results across the mines and prioritization of which ones were at a higher risk of biodiversity loss after considering the combination of pressures on nature derived from the mining operations and other anthropogenic activities in the area, such as farming or logging. Finally, the Integrated Biodiversity Assessment Tool (IBAT) was used to determine what mines were most suitable to implement a project that would contribute more to preserving and restoring biodiversity. Biodiversity stewardship is recommended as an alternative to align efforts to protect biodiversity at regional level.

Table 1. Summary of mine characteristics and total emissions per mine

Name	Location	Ore grade (g/ton)	Finished product composition	Finished product in kg (2021)	Total (kgCO_2e/ kg pure gold)
PE-002	Peru	14,24	48,9% gold, 41,2% silver and 9.9% others	1.097	5.340
PE-006	Peru	0,14	97% gold, 3% others	40	90.780
CO-007	Colombia	4,5	99,3% gold 0,7% others	188	25.792
CO-002	Colombia	0,106	97%	48	62.738
CO-011	Colombia	6-7	88,4% gold, 11,6% silver	15	5.832

(Source: South Pole, 2022)

For the analysis on the water use, water consumption data was collected from the mines, and water monitoring reports were reviewed to assess the water quality before discharge. The methodology used for analyzing the impact of water consumption by the mining operations was the AWARE methodology. AWARE allows for assessing the impact on the water basin from which the water is extracted. In this sense, Peruvian mines are more exposed to water distress than the mines located in Colombia, which have more reliable access to water resources. It is recommended to have better control over water consumption and develop better water management systems, especially considering the high dependency on water for mining operations and the expectations of more competition for water use.

For the more extensive versions of the three studies in Spanish:

- Climate impact: https://ororesponsable.org/wp-content/uploads/2023/04/South-Pole_Reporte_Carbono_Noviembre-2022.pdf
- Water: https://ororesponsable.org/wp-content/uploads/2023/04/South-Pole_Resumen_Agua_Noviembre-2022.pdf
- Biodiversity: https://ororesponsable.org/wp-content/uploads/2023/04/South-Pole_Resumen_Biodiversidad_Noviembre-2022.pdf