



Introduction



▲ Copper-plate charter of Budhagupta dated anno 168
Image credit: By Shirazibustan

Economies need nature. Oxygen, water, food, energy, minerals, and materials are just a few of the products of natural capital.

Since early human history, copper has held an important position in human development. Today, its value is no less significant.

Copper continues to have widespread use for humans in applications from telecommunications to electrical power generation. As a result, copper mining has become a widespread industry with significant impacts to both human communities and the environment. To date, copper mining has been restricted exclusively to terrestrial mine sites. In this report, we explore the potential impacts of deep seabed mining through several analyses that compare the impacts of a proposed deep seabed mine site known as the “Solwara 1” project with three terrestrial mine sites located in distinct environments. This study utilizes a natural capital accounting approach to analyze the impacts of each mine site.

Economies need nature. Oxygen, water, food, energy, minerals, and materials are just a few of the products of natural capital. Indeed, all built capital is physically constructed out of natural capital, using energy derived from natural capital. Understanding the qualities, quantities and monetary value of natural systems falls within the realm of social and environmental analysis and natural capital accounting. Modern business, governments and non-profits rely on accounting to provide a clear tally of the value of assets and the streams of benefits or costs to which those assets are tied. Social and natural capital, however, have often been left off the balance sheet, at great cost to the communities and ecosystems with which they are connected. There have been many efforts in recent years to begin valuing natural capital and the environmental benefits (ecosystem goods and services) that flow from it. The United Nations, the World Bank, Global Reporting Initiative, and other organizations have initiated social and natural capital accounting efforts. For example:

- In 2007, the United Nations launched an initiative called “The Economics of Ecosystems and Biodiversity” (TEEB). TEEB laid out a framework and a database that demonstrated values for biodiversity and other services provided by ecosystems, and identified mechanisms for capturing these values in decision making.⁴ This study adapts and builds upon the TEEB framework for categorizing and valuing ecosystem services in Analyses II and IV.
- The Global Reporting Initiative (GRI) has initiated voluntary sustainability reporting guidelines for private firms in many sectors



▲ Reconstruction of the copper axe of Ötzi the Iceman, a man who lived around 3,300 BCE
Image credit: Bullenwächter

of the economy. A number of copper mining companies provide GRI reporting, although a more complete physical reporting is needed. Analysis III in this report use several key GRI categories and examine how Solwara 1 compares to existing copper in a number of environmental impact areas (e.g. freshwater use, CO₂ emissions).

- Earth Economics houses the most comprehensive database of natural capital valuation studies in the world, which was used to conduct Analysis IV. The Earth Economics database contains the TEEB database as well as five other ecosystem service databases and thousands of unique studies not yet contained in other databases. Within the field of natural capital accounting, Earth Economics is a globally recognized leader in effectively applying natural capital valuation to decision-making and in advancing the field.
- At the macroeconomic level, the World Bank has initiated a program at the scale of the nation, called the Wealth Accounting and Valuation of Ecosystem Services (WAVES) program, which is developing methods for country-level natural capital accounting. The WAVES program has initiated work in Botswana, Colombia, Costa Rica, Madagascar and the Philippines.⁵ This study is conducted at the project level and does not use the WAVES framework; however, it is hoped that information from project-level analyses like the one presented in this report can eventually be used to inform WAVES measures.

Social and natural capital have often been left off the balance sheet, at great cost to the communities and ecosystems with which they are connected.

The goal of sustainability implies a relationship between human economies and natural systems that leaves natural capital in good health, or restores it to a sufficiently healthy state to support biodiversity and ecosystem services. In the context of copper mining, there is much that could be done to ensure that the mining results in lower impacts to natural capital. This report contributes to the body of knowledge surrounding copper mining and identifies and monetizes specific impacts at four mine sites.

In the next few sections, a brief history of copper and a description of copper's use in modern society are presented before reaching the first analysis, which examines two alternatives to copper mining: recycling and substitution. Analysis I provides an assessment of whether or not recycling and substitution are viable alternatives to copper mining.

Following this first analysis, this report then turns to the Solwara 1 project area, describing the state of knowledge of this area of deep seabed.

Selection of Comparison Mines

Next, the report provides a background in natural capital accounting before presenting the final three analyses, which each provide a comparison of the impacts of the proposed Solwara 1 deep seabed mining project and three terrestrial copper mines: Bingham Canyon (Utah, USA), Prominent Hill (South Australia, Australia), and Intag (a proposed mine in Intag Province, Ecuador). These mines have been chosen for comparison with Solwara 1 for the following reasons:

- The Bingham Canyon Mine is typical of the large scale terrestrial copper porphyry deposits that currently account for most of the world's copper supply;
- The Prominent Hill Mine holds a copper deposit that yields a similar annual amount copper as the projected copper yields for the Solwara 1 Project;
- The proposed Intag Mine is located in an area containing cloud forest that is considered to be a unique and sensitive terrestrial ecosystem with significant species endemism. Similarly, the vent ecosystems of the deep sea are also considered a unique and sensitive ecosystem with notable species endemism.

Analysis II provides a description of the ecosystem goods and services expected to be impacted by the Solwara 1 project while simultaneously providing a parallel description of the ecosystem goods and services of the three aforementioned terrestrial mines.

In Analysis III, Solwara 1 is next compared to these three copper mines in terms of the physical quantities of inputs (water, energy, land) that are required to produce one metric ton of copper. We also quantify the amount of mineral waste and carbon dioxide emitted for every metric ton of copper produced.

Finally, in Analysis IV, the dollar value of annual natural capital ecosystem goods and services lost is estimated for Solwara 1 and the three comparison mines, as is the dollar impact of carbon dioxide emissions. The ecosystem service analysis is based on existing academic ecosystem service valuation studies, and is conducted similarly to a business or house appraisal process.

