Analyzing Initiatives for future use of the Timna Industrial Area in southern Israel

WPI

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By:
Maya Angeles
Daniel Correa
Brian-Marcio Montenegro
Grace O'Reilly

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Prof. Isa Bar'On
Worcester Polytechnic Institute
Prof. Seth Tuler
Worcester Polytechnic Institute
Itai Shanni
Eilot Regional Council

Abstract

The Timna Industrial Area is located in the Eilot region in southern Israel and is currently home to abandoned copper mines. There are multiple stakeholders interested in developing the site since the area is one of the largest sites in Israel zoned for industrial use. We examined three proposed initiatives: data centers, copper mining operations, and tourism. We reviewed information about these activities and conducted interviews to provide the Eilot Regional Council with analyses of the social, economic, and environmental sustainability of each proposal.

Table of Authorship

	Author	Editor
Abstract	Maya, Grace	All
Acknowledgement	Grace	Grace, Maya
1. Introduction	All	All
2. Background		
2.1 Profile of area	Daniel	All
2.2 Profile of site	Brian	All
2.3 Impact	Daniel	All
2.4 Industries	Maya, Grace	Maya, Grace
2.5 Framework	Grace	Grace, Brian
2.6 Summary	Grace	All
3. Methodology		
3.1 Evaluate sustainability	Grace	Maya, Grace
3.2 Assess opinions	Grace	Brian, Maya
3.3 Sustainability criteria	Grace, Maya	All
3.4 Decision matrix	All	All
4. Results		
4.1 Proposals	Brian, Daniel	Brian, Maya
4.2 Criteria Tables	Grace, Maya	Grace, Daniel, Maya
4.3 Decision Matrices	Grace, Daniel	Grace, Brian, Maya
4.4 Community Interviews	Brian	Brian, Maya, Grace
5. Discussion		
5.1 Interpretations	Brian	Brian, Maya
5.2 Implications	Grace	Grace, Maya
5.3 Limitations	Maya	Maya
5.4 Recommendations	Daniel	Daniel, Maya
6. Conclusion	Grace	Grace, Maya
Formatting	Grace, Daniel	

Table of Contents

List of Figures and Tables

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1. Introduction

The Timna Valley is a geological wonder located in southern Israel. The valley is decorated with mountains of different rock, natural boulder formations, and massive ridges, turning Timna into an impressive sight. However, Timna is just as archaeologically important as it is beautiful. Along with natural rock formations, the Timna landscape is dotted with man-made holes and tunnels that traverse throughout the valley. These holes and tunnels are actually ancient mines used to extract copper. Due to abundant veins of copper within the region, ancient civilizations, specifically the Egyptians and the Midianites, took advantage of the surplus to create products such as tools, weaponry, and jewelry. Although it has been 4,000 years since the beginning of copper mining in the Timna Valley, copper still remains. In fact, there were numerous modern copper mining operations in a separate area of the Timna Valley beginning in the 1950s, this eventually became the Timna Industrial Area (figure 6). However, these mines are no longer in use and there is a need for a greater variety of industries in the region. Currently there is an opportunity to develop the modern mine ruins of the Timna Industrial Area to benefit the local population.

In 1958, copper mining excavations began south of Timna National Park in what would be known as the Timna Industrial Area. Copper mining in Timna grew as approximately 950 workers were involved in producing copper ore. Besides the mining facilities in Timna, other facilities were established, such as crushing and grinding stations, copper cement precipitation launders, leaching tanks, and sulphuric acid production units. In addition to copper, manganese sulfate was also manufactured. At the end of 1985 the copper mining operations ended as prices of copper decreased while costs of mining procedures inflated (“TIMNA COPPER MINES - History.”) .

Today, the closed copper mine remains untouched and neglected. The lack of restoration practices left large open pits and piles of waste across the site (figure 6). The area is one of the largest available tracts of land that is open for industrial development and it is currently unusable; this has interested various companies in using the site for development.

The local communities surrounding the area rely heavily on agriculture and tourism, where much of the tourism is attracted by the unique landscape. The Arava Valley is a breathtaking landscape; the area is popular with mountain bikers and hikers. Many of the communities in the area rely on this type of tourism to supplement their income. Due to this, there is a strong interest in maintaining the ecosystem both from an economic and environmental point of view. Developers have been chased out of the area in the past for proposing ideas that were environmentally damaging and poorly received by the community. Preserving the natural landscape and natural processes of the Arava ecosystem is a strong focus of the community. The ecosystem is extremely delicate and climate change has impacted the area and will cause harsher conditions in the near future. The reliance on only a few industries has caused climate change and various disasters to have a much heavier impact on the area economically as well as environmentally.

Finding suitable and desired development for the Arava region is a difficult task. Our goal is to analyze each initiative and gather community perspectives to assist the Eilot Regional Council with their decision. This will allow them to narrow their research and questions to get the information and data that will be most beneficial for their goals.

2. Background

2.1 Profile of Area and Communities

The Timna valley is located at the southern end of Israel in the Negev desert; more specifically, the Timna valley is located in the Arava region and in the Eilot municipality. The region is home to the Timna Valley National Park as well as the Timna industrial park. The Arava region is located within the Negev and is a hyper arid desert with low rainfall averaging 25 millimeters per year. Through the year, Timna experiences a winter with average temperatures of 44°F to 65°F and summers of 75°F to 100°F. The Timna Valley is 9 by 10 square kilometers high and surrounded by 500 meter cliffs. Timna's east end has short steep channels that drain from the tops of the cliffs, whereas the west side has moderate streams from the elevated plateau (Beyth et al., 2018).

The region is made up of thirteen different communities, ten kibbutzim and three villages, each of which are represented in the Eilot Regional Council (figure 1). The Eilot Regional Council oversees all the communities in the area, and governs itself similar to a city council. This council helps communities by sharing news, providing educational resources and cultural information, and innovative ideas (*מועצה אזורית חבל אילות - ערבה דרומית*, n.d.). Each community has their own distinct economic and social system; however, each community works together to govern the region.

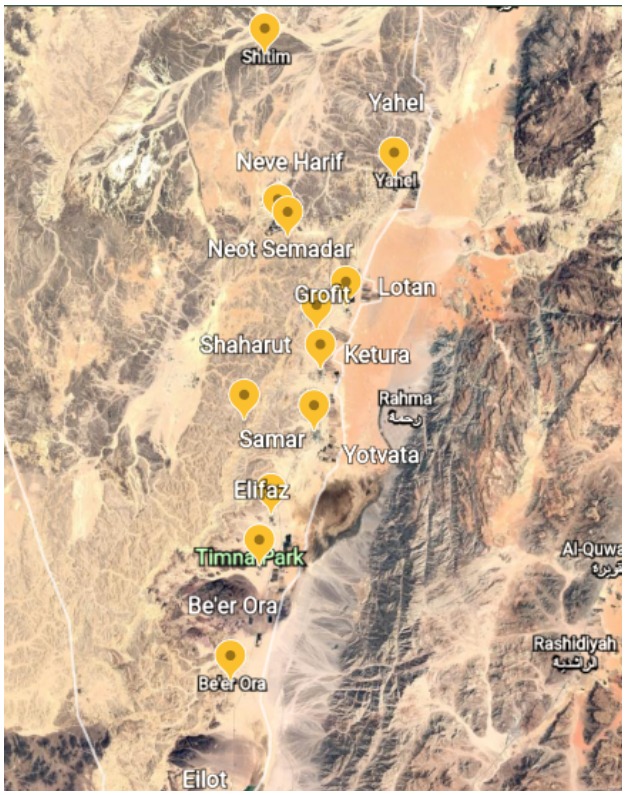

Figure 1: Map of all communities in the Eilot Regional Council

2.2 Profile of the Site Today

The Timna Valley industrial site is a large tract of land that is open for development. The reinstated copper mining excavations from 1958-1985 have left heaps of rubble, large open pits, and chemical waste. (Timna Copper Mines LTD, *The History of Expertise*). These pose a threat to the ecosystem and the economy of the communities surrounding the Timna Valley.

Since the closure of the copper mines, the land has not undergone any sort of restoration or rehabilitation. Pituach Meshamer is a sustainability development ideal the Eilot Regional Council and the surrounding communities are interested in pursuing. Pituach Meshamer is when development does not disrupt the natural processes of the environment and develops alongside nature. (Itai Shanni, 2022).

Several companies have been aware of the tremendous value in remediating this region in the past. The Southern District Planning Committee was in the process to authorize the construction of a resort hotel in the Timna Valley. However, the Environmental Protection Ministry, the Society for the Protection of Nature in Israel, and Mayor Yehiel Zohar of Netivot submitted a joint appeal against this decision. They argue that this resort was an ambitious project and that building such a resort would cause irreversible damage to the area. Gilad Erdan, the Environmental Protection Minister, promised to "undermine the decision and activate all means possible in order to prevent the destruction of nature and unique landscape" when the committee first approved the construction of the resort (Udasin, 2012). The focus of the environmental committee was to preserve the natural environment of the Timna Valley, and the proposed idea of a resort did not fit with how the local community envisioned land development. The proposed solutions offered by these corporations failed to consider the perspective of the surrounding communities regarding environmental, economic, and social development.

2.3 Impact of Copper Mining

Previous copper mining in the Timna Valley had a negative effect on the environment. The health of plants, wildlife, and the safety of people have been at risk by copper mining operations. To accurately analyze the different initiatives for the Timna industrial site, information about the current state of the environment is necessary. This allows for a more accurate representation of each initiative's effects on the Timna environment.

Understanding the environmental effects of copper mining in the Timna Valley allows for better insights into the difficulties of working in such an area. Timna's history of copper mining left behind metals and toxins, such as manganese and lead, that pose a health risk to humans and wildlife. Since the Timna Valley is an arid desert, the contaminants are much more likely to become wind-borne dust that can contaminate local ecosystems. This wind-borne dust can easily travel and affect human health and local water sources. Human health is at risk when these contaminants infect natural resources in the environment; people may indirectly consume these infected resources and affect their health (US EPA, 2017). The waste piles from previous mining can negatively affect the ecosystem's natural fauna and flora. With the manganese contaminating the environment, the plants in the area experience toxicity and deficiency symptoms which can cause cell walls to swell and leaves to wither (Manganese (Mn) - Chemical Properties, Health and Environmental Effects, n.d.). Additionally, lead is present which decreases the growth and reproduction in the fauna and flora in the area, and neurological effects in vertebrates (US EPA,

2016). In order to properly reuse the Timna Industrial area, the waste needs to be properly remediated to ensure the safety of the community and environment for years to come.

Along with the toxic waste of copper mining in the Timna Valley, there is a risk of health problems. This threat is caused by underground voids and hazards that can affect the surface. Utilizing modern technology, diffraction stack imaging was used to identify underground voids in the Timna Valley. This tool allows for increased safety by creating a map that allows people to safely navigate areas above and below the surface (Wechsler et al., 2020). Old copper mines have deformations and displacements underground due to years of stress on the rock masses; this results in rock bursting from the stress and elastic buildup of former mining practices. These risks should be fully understood so that future uses of the region will be safe from ground movements.

2.4 Interested Industries

The closure of the AHMSA mine was the end of copper mining operations at the site; the surface mine now stands neglected and vacant. However, land is attractive for development. Various companies and entrepreneurs have proposed several industries to implement in the mine. There are two initiatives stakeholders are interested in: data centers, and mining. Due to the proximity to Timna National Park, there is also the possibility of a tourism site. Each of these proposals can be applicable to the region, however, they differ in the benefits they can bring to the area.

Data centers are facilities that house routers, firewalls, storage, servers, and other apparati to ensure data and applications are transferred efficiently and effectively (*What Is a Data Center?*, n.d.). Data centers are essential to ensure the functionality of online services such as: online communication, artificial intelligence and machine learning, virtual desktops, along with other applications. A key characteristic of data centers is that the building requires a large amount of energy to run efficiently and ensure that all of the servers are running properly to keep the transfer of information uninterrupted.

The implementation of a data center is of interest for the closed mine(s) due to the installment of the Blue Raman cable system (figure 2). The Blue Raman cable is a line of subsea fiber optic cables that are used to provide high speed internet to customers. The Blue Raman cable is the latest installment to connect Italy, France, Greece, Israel, Jordan, Saudi Arabia, Djibouti, Oman, and India, with high speed fiber optic cables (*Google Officially Announces Blue and Raman Cable Systems - Submarine Networks*, n.d.).

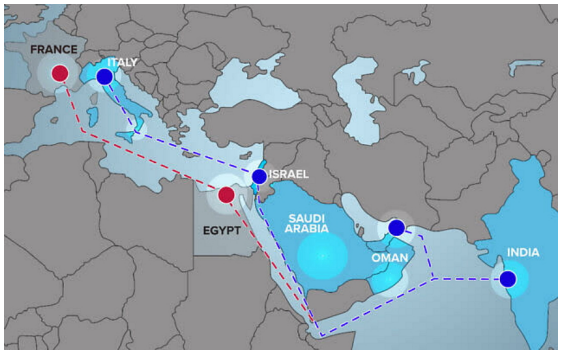

Figure 2: Map of Blue Raman Cable plans. (*Google Officially Announces Blue and Raman Cable Systems - Submarine Networks*, n.d.)

Stretching from Tel Aviv to Aqaba, Israel will act as one of the connection points for the Blue Raman cable. The plans for the Blue Raman cable show the path of the fiber optics passing over the Timna Valley region (figure 3). Investors have suggested using the abandoned mine site as a site for a solar powered data center connected to the Blue Raman fiber optic cable. Due to the location, solar energy has the potential to provide enough power for the center to run during the day.

Figure 3: Map of where the Blue Raman Cable will be in Israel.

Another option is the implementation of a tourism site within the Timna Valley. Tourism is a large industry for the area with many outdoor activities offered throughout the region. The city of Eilat receives 80% of its income from the tourism industry (Line, “Tourists Love Eilat, but Hitting Its Beaches May Become Difficult.”). The closest branch of Ben Gurion University for the area is in Eilat, this specific branch only offers degrees in international tourism and hotel management, their reasoning for this on their website is that the area has many opportunities for students interested in studying tourism (בית הספר הבינלאומי למלונאות ותיירות, n.d.).

Another proposal is to resume copper mining operations within the abandoned mine site. The company who previously owned the mines, AHMSA, has sold the mines to two Israeli companies who want to resume mining. In addition to extracting copper from the ground, they also want to process rock on-site using a technique called heap leaching. This is different from the AHMSA work and will be the first time in recent years that copper will be processed in Timna. Although the reopening of the mining site is viable, there has been resistance from some of the local population due to environmental and economic concerns.

2.5 EPA Framework

The Environmental Protection Agency of the United States of America created a basic framework for analyzing and reusing abandoned and contaminated land (figure 4). This enables us to understand how the site should be approached for analysis of the various proposals listed (US EPA, 2015).

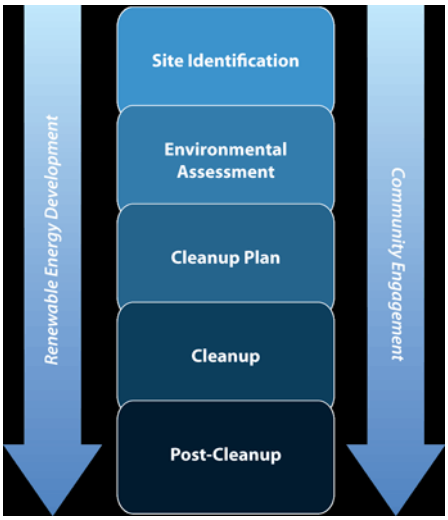

Figure 4: EPA abandoned land cleanup framework. (US EPA, 2015)

After the site is identified, it must be assessed to see what types of contaminants and hazards are still present in the ground and surrounding area. This assessment will guide the subsequent steps of the process. Once the survey of the site is complete, a set plan must be laid out describing how to remediate the land in accordance with environmental safety standards, this includes a focus on sustainability in some form. The rest of the steps are focused on the actual cleanup effort. A great example of this process is the Questa Mine site in New Mexico (US EPA, n.d., p. 1). The site was a molybdenum mine that was closed; after being identified by the EPA as a site to be rehabilitated, the site was assessed for environmental damage and issues such as contaminated groundwater and acidic waste rock. In this case, the EPA created a plan of action for the cleanup effort, and put it into motion. The site is now a solar energy field and is productive once again.

Another important framework that could be useful to complete our goal is the EPA's specific framework regarding renewable energy projects that focus on using formerly unusable land (figure 5).

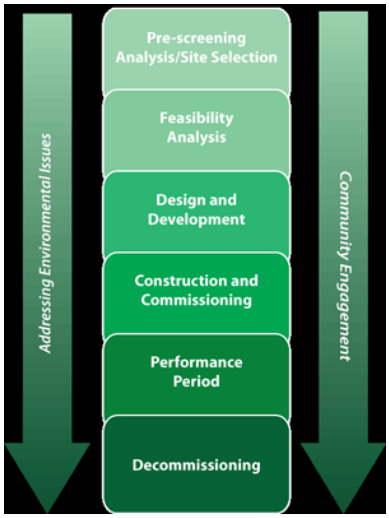

Figure 5: EPA Renewable energy project framework. (US EPA, 2015)

Our project is focused on the first and second steps of this process. Our site was preselected for us, but the available resources and analysis of the site are still needed to guide our work. A feasibility analysis of each of the potential initiatives is required to review the specific needs of each initiative and analyze the social, environmental, and economic impacts as well. Our project is focused on completing these objectives, and this framework is applicable to guide our further research. An example of this process can be seen in a reused copper mine in Butte, Montana. The site was rehabilitated using the general framework from the EPA to bring the large site to a safe condition for reuse. After the site was rehabilitated, the various agencies completed a "Programmatic Agreement" that allowed the project to meet various requirements from the Environmental Protection Agency; included in this agreement was an analysis of the economic goals of the region and goals for the sites' reuse (EPA, 2014, p. 6). The site now has a variety of uses including a sports complex, a park, and an activity center (EPA, 2014, p. 7). A key part of this process included holding town halls and open meetings that allowed the public to voice their concerns and their community's vision. This is a critical part of our project and will allow us to better understand the community's values. This is crucial for the successful implementation of any proposed initiative.

2.6 Summary

The Timna Industrial area is currently empty and useless, this is problematic because the region severely lacks a diversified economy, and the area is one of the largest tracts of land zoned for industrial use. This site is an important opportunity to introduce a new economy to the area. The following section will outline how we plan to help solve this problem to empower the communities in the area.

3. Methodology

The goal of our project was to analyze the feasibility of data centers, copper mining operations, or a tourism attraction for implementation in the Timna Industrial area; this was to help provide the Eilot Regional Council with an explanation of the economic, social, and environmental impacts of each initiative and collect a sample of community members concerns. The purpose of this chapter is to outline the project objectives and the tools used to achieve our goals. Our goals were to:

- Evaluate the implications of potential initiatives.
- Collect the opinions and concerns of community leaders and the local population for each initiative.
- Analyze if the proposed initiative can be supported environmentally, socially, and economically.

3.1 Evaluate the Sustainability of Potential Initiatives

Our first objective was to assess the sustainability of each proposed initiative. To accomplish this, we completed secondary research to understand the social, environmental, and economic aspects of each potential initiative. We used the EPA model of sustainability criteria to assess each initiative to understand the project's implications. We focused on peer-reviewed journal articles and scholarly sources to gather information. This information was then compiled into a table for further analysis as explained in section 3.4 below. By using this data to better inform our sponsors and the Eilot community, it will allow the council to choose the best option for their needs (Bacciotti et al., 2016, p. 368)**.**

3.2 Assess Opinions and Concerns of Community Members

To evaluate each potential proposal, we collected the opinions and concerns of various community members about each initiative. We conducted semi-structured interviews with six community members in the Eilot region.

We adjusted our interview questions and style based on the interviewees background and knowledge (Mathers et al.,2002, pg. 2). We identified and contacted interviewees with the help of our sponsor, Itai Shanni. We focused our contacts on people who lived close to the Timna industrial area and/or had experience with the Eilot Regional Council regarding development of the area. The focus of these interviews was to understand how each interviewee envisioned the future of their community, their concerns, and their opinion on each proposed initiative.

3.3 Sustainability Criteria

We created questions for each initiative to help guide our decision matrix analysis; we used the definition of sustainability to help form the content of our questions. Sustainability is "concerned with the well-being of future generations and in particular with irreplaceable natural resources" (et at. Kuhlman). Furthermore, sustainability is commonly measured in three dimensions: economical, social, and environmental. Although the inclusion of economic, societal, and environmental elements within sustainability creates a more holistic understanding of sustainability, there are still discrepancies within the definition of sustainability. In addition to these economic, societal, and environmental hazards, it is important to consider longevity as a

factor. Focusing on longevity ensures that what is "sustainable" is not only true in the present, but also in the future.

We used sustainability to inform our criteria in our decision matrix. We found the use of sustainability criteria to be appropriate because it evaluates if each initiative would be long lasting in the area and compatible with regional values. We used the economic, social, and environmental sustainability factors as subsections within our decision matrix, and then we devised questions focused on these factors. For example, economic sustainability includes research on how the different initiatives could affect the local workforce and the amount of tax income the regional council would receive from each initiative. Environmental sustainability includes any effects the initiative could pose on the natural environment, including the amount of resources and energy used by the industry, toxic and rare material use, and the types of pollution possible. Social sustainability includes analysis on how each initiative can affect the local population, and how it affects different sections of the population (Pavlovskaia, "Sustainability Criteria.").

3.4 Decision Matrix Analysis

Our third objective was to analyze the environmental, societal, and economical impacts of each proposal. In order to determine if the proposed initiative is sustainable, we implemented a decision matrix to compare them with respect to our sustainability criteria. A decision matrix allows the comparison of different information through analysis of different criteria. A decision matrix is organized into sets of rows and columns; this structure allows for analysis between different data relationships. We are using a qualitative comparison, this was created by ranking each category and initiative as high, medium, or low based on what made sense for the criteria. If an initiative used the least amount of resources it would be labeled low. After this is complete, each cell is colored according to how desirable it is for the region. The criteria of each decision matrix can be seen below in the results (Sorooshian, 2021).

This procedure is important in understanding the capabilities of the available resources; it allows us to properly evaluate the proposals in terms of the needs of the land, the people, and the economy. The rating system of the decision matrix allowed us to quickly and effectively display our findings in an easy to understand format. Our goal is to give an in-depth analysis of the three initiatives to the Eilot Regional Council to guide their discussions and decision on the Timna mine issue.

4. Results

Using the methods described earlier, we were able to analyze each initiative using a variety of sources. We researched the basics of each initiative and the potential effects of the initiatives could have on the Arava Valley. We interviewed community members and learned about their goals and aspirations for their community and their concerns about the different initiatives. Once our data was collected, we input our data into the criteria table and created our decision matrix.

4.1 Proposal Examination

4.1.1 *Data Center*

According to community member D, the community's low salary was a major concern. The data center proposal is projected to have a pay range of 324,000 NIS/year for the first two years of work experience up to 516,000 NIS/year for six plus years of work experience. (CTech, 2021). Community members A and B have expressed desire in creating more jobs and bringing more manpower in the region. A data center in this region would be expected to create one hundred and fifty job opportunities (Stark, 2022). Data centers are generally autonomous compared to other technical occupations; however, there are essential jobs needed to keep the facility operational. These jobs include engineers, maintenance workers, and technicians (Heslin, 2015). Due to a lack of technical education opportunities in the region, there is a lack of workers experienced with data center operations. This causes the workforce to consist mostly of national workers and a limited number of local workers (Stark, 2022). However, there are opportunities to receive education at institutions like the Technion in Haifa outside the Arava; the workers will need to undergo specialized training in order to work (U.S. Chamber Technology Engagement Center, 2017). Data centers are projected to have a 13.4% CAGR growth between 2020-2027 (Wood, 2021). Technologies that require the use of data centers have seen an increase in future demand, an example is cloud services which function by external data centers. The usage of data centers excellently adapts to changes in technology advancements, specifically data-generating and data-hungry technology such as IoT (Also, 2022). As mentioned earlier, data centers are highly autonomous, yet they do still require some sort of maintenance. The different tier levels indicate redundancy and the structure of how certain failures are addressed (U.S. Chamber Technology Engagement Center, 2017). The Eilot Regional Council has two goals to achieve, to create more jobs and to receive taxes from the proposals. This proposed data center is expected to generate around ten million NIS yearly in revenue (Stark, 2022).

Data centers are not green industries, however can be greened by using renewable energy. It is important to estimate how efficiently the types of resources and energy are used and distributed in data centers. During construction, many resources are used to create the infrastructure for the data center, and during operation lots of energy is needed to maintain functionality (Union of Concerned Scientists, 2013). This data center proposal is planned to only use renewable energy (Stark). Data centers also use rare materials for computer boards and servers, however, these materials are becoming increasingly scarce and expensive (Keith, 2019). Touching upon how data centers are not green industries, even renewable energy has an impact on the environment. Solar panel life cycles impact the environment. The manufacturing process of the panels uses a large amount of energy and the waste of the solar panels is difficult to

process and reuse, and computer manufacturing is also not green (Nunez, 2021). If faced with the problem of climate change, data centers would have to adapt. One way to do so is to incorporate more renewable energy techniques to work towards “off-grid” technology (John MalonePrincipal & David HigginsData Center Director, n.d.).

4.1.2 *Mining Operation*

The average salary of a mining engineer in Israel is 241,492 NIS annually (Mining Engineer Salary in Israel, n.d.). The number of job opportunities that would be created by copper mining operations would be around 40 to 400 openings. However, these opportunities are not uniform across all copper mining operations (Statista, n.d.). The workbase of these employees is unknown, they are likely to be a mix of local, national, and international workers. These workers will need to undergo specialized training to ensure safety and quality control (Development, n.d.). The estimated tax revenue from this proposal is around two million NIS annually (Stark). Jobs and opportunities in this industry are projected to grow 3.7% annually between 2021-2029, with this growth, the industry is expected to be needed in the future (“Global Copper Output to Grow over the next Decade – Report,” 2020). Levels of jobs can range from entry-level jobs to machine operators and managers. The number of workers and the number of job positions depends on the size of the mine. (BC Jobs, 2013). It is unclear whether a mining operation will be able to adapt to new technologies, it depends on the company. It's common for industries to keep to the standard quo and refuse change to save money. There are a multitude of maintenance and safety checks this industry will need to maintain. Examples of these checking practices include: Reactive, Preventative, Predictive, and Proactive maintenance (Tripathy, n.d.).

The mining initiative in Timna will have large environmental effects in the region. Copper mining uses extensive resources of energy and oil to operate the machinery required (Stark, 2022). As seen from Timna’s previous copper mining operations, there a considerable amount of pollution that occurs when mining for copper. This is evident from the current state of Timna’s industrial site, large creators, piles of toxic materials including manganese and lead, the disruption of the natural landscape, and the contamination of local resources (Stark & Shanni, 2022). Additionally, heap leaching is performed to extract the copper, a very destructive process that produces immense amounts of heavy metal and toxic pollution (Ghorbani et al., 2016). The issue of climate change will add challenges to the mining operation initiative because the rising temperatures will adversely impact the employees and machines (Jackson, n.d.). Continuing copper mining operations in Timna’s industrial region would bring a familiar industry to the area that already has proven to work before. Copper mining would bring many jobs to the surrounding communities and revenue for the economy. However the environmental effects associated with the mining initiative are largely negative with the pollution and environmental damage to the area as well the surrounding communities in Eilot.

4.1.3 *Tourism*

In the Eilat region tourism pays roughly about 19,769.49 NIS annually with most tourism jobs paying minimum wage (“Living in Eilat,” n.d.). Since tourism is a large industry in Eilat the expected employment numbers, revenue and workforce base vary too much to have an accurate depiction for the Timna industrial region. Tourism requires specialized training and education to work within Eilat and the Eilot region (בית הספר הבינלאומי למלונאות ותיירות, n.d.). Additionally, there is local education to support this initiative; the branch of BGU in Eilat focuses mainly on

tourism and hotel practices. Due to Israel's large tourism economy, there is a large demand for tourism in the future along with 6% growth of national GDP by 2025 (Statista, n.d.).

The tourism initiative in Timna will have an impact on the surrounding environment. The tourism industry has shown to use natural resources such as land, water, along with energy (Zahedi, 2008). Depending on the specific tourism initiative, environmental impacts vary largely but common impacts include soil erosion, increased pollution, water pollution, natural habitat loss, wildlife endangerment. Additionally the trash and waste produced by people in the tourism industry strains the environment. However, tourism in the region has the potential to protect the environment; see Timna Valley national park (Zahedi, 2008 & Sunlu, n.d.). Currently with climate change, different tourism sites would react differently due to the difference in ecological diversity. The largest concern would be the rising temperature that would make tourists more uncomfortable over the years (Jackson, n.d.). With the push of renewable energy in the Eilot region, specifically solar energy, the tourism initiative would most likely utilize renewable energy (Israel to Reopen Eilat, Dead Sea, Declare Them "Green Tourist Islands," n.d.). Depending on the specific tourism initiative, the use and production of the toxic materials can occur. However some industries do not produce toxic materials such as nature reserves (Mikhailenko et al.,). The tourism proposal focuses on education for people coming to the Eilot region and fun activities that make tourists' time in Eilot memorable. While at the same time giving back to the communities in the area with more revenue and more foot traffic for more tourism in their community.

Figure 6: Photos of the Timna Industrial Site

4.2 Criteria Tables

The criteria table is used to compare the proposed initiatives with the economic, societal, and environmental criteria that we have created (table 1). The information in the criteria matrix is data pulled from various sources to create a qualitative understanding of each initiative; the criteria matrix allows for a detailed description of how each industry impacts the Eilot region.

	Criteria 1	Criteria 2	Criteria 3	...	Criteria n
Initiative 1					
Initiative 2					
Initiative 3					
...					
Initiative n					

Table 1: Blank Criteria Table

Table 1 represents how our criteria table is formatted. Each industry is listed in the farthest left column, and each criteria is listed in each consecutive column. Appropriate information is listed below each column and in the proper industry row. This format allows for an easy information comparison between each initiative proposal.

4.2.1 *Economic Criteria*

	Economic										
	Salary What is the expected pay?	**Employment Numbers** How many job opportunities will this proposal create and keep?	**Revenue** How much revenue and tax revenue is generated yearly?	**Workforce Base** Will the employee base be local, national, or will international employees be brought in?	**Workforce Training** Will there need to be specialized training for this proposal?	**Education** Is there local education to support this proposal?	**Future Demand** Will this proposal be needed in the future?	**Industry Growth** Are jobs and opportunities for this proposal growing?	**Industry Upkeep** what types of maintenance and support will this proposal need	**Technology Adaptability** Will this proposal adapt to new technologies as they are introduced?	**Job Range** What types of jobs will be available?
Data Center	Average salary for Data Scientist 324,000.00 NIS/yr; 0-2 years | 432,000 NIS/yr; 3-5 years | 468,000 NIS/yr; 6+ years | 516,000 NIS/yr Managerial	Large Data Center: 150 People | Small Data Center: 75 people 1,668 people (on construction), 157 annually after that	31,699,701.00 /yr Tax: Around 10 million Shekels yearly	Mostly local	There will be a need for specialized training, data centers train local workers	No, you must leave the Arava to get this education	Yes	13.4% CAGR growth from 2020-2027	Tier I needs cooling equipments. Tier II needs redundant critical power and cooling equipments Tier III have no shutdowns for equipment replacement and maintenance Tier IV include a fault tolerance whichstop short the failure of equipments	high tech industries are more likely to embrace new tech	Few engineers, maintenance workers, and technicians. Overall rather autonomous
Copper Mining	Average salary of a Mining Engineer in Israel is 241,492 ILS per year; 116 ILS per hour	Small Copper Mine: 40 People | Medium Copper Mine: 400 People. However, these populations are not uniform across all mining operations	Tax: Around 2 million Shekels yearly	Unknown, probably a mix of workers	There will be a need for specialized training	No, you must leave the Arava to get this education	Yes	3.7% yearly growth from 2021-2029	There are a multitude of maintenance and safety checks. Example of these checking practices include: Reactive, Preventative, Predictive, and Proactive maintenance.	It depends on the company. It's common for industries to keep to the standard quo to save money	Levels of jobs can range from entry-level jobs to machine operators and managers. The number of workers and the number of job positions depends on the size of the mine; however there are a wide variety of jobs positions. Example include,
Tourism Attraction	19,769.49 NIS/yr Most tourism jobs pay minimum wage.	Unclear; Dependent on the type of tourism	Unknown	Unknown, Probably local and international workers	Yes; people in the area typically require special training/education to work within the tourism industry.	There is a branch of BGU in Eilat that focuses specifically on tourism	Yes	Expected to be 6% of national GDP by 2025	Depends on the tourism industry	Depends on the tourism industry	Depends on the tourism industry

Table 2: Economic criteria table

The economic criteria we chose will give good insight into the economic effects that each initiative could have on the region (table 2). Each criteria was chosen to help reveal a certain aspect of economic sustainability as explained below.

Individual salaries: It is important to know the expected salary range for workers to understand if the amount will be a desirable wage for the local population. If salaries are not competitive it will be difficult to find local workers.

Employment Numbers: How many employees will be needed to work to keep the industry running? This information will let us know if the local population is large enough to support the initiative, or if people must be brought in from other areas to be able to adequately support the industry.

Revenue: How much tax revenue is generated for the regional council? It is important to understand if the industry would benefit the community and if the industry would meet the development goals for the regional council.

Workforce base: Where are the employees from? Will the industry recruit people from the local area, or will the industry bring in international employees? What is the motivation? It is important to know how the introduction of an industry could affect the local workforce and population; with the small communities, a small influx in population could have unknown consequences for the local culture.

Workforce Training: Are there available resources in the area that can provide local communities the skills for this industry, or will workers leave the area for education? This will influence how many people are qualified to work in the industry in the Arava.

Future Demand: Will this industry be needed in the future? Is this a growing industry that will be needed for many years or will it become irrelevant in the future? This will help understand the longevity of the industry and if it will succeed in the future. This will also estimate if the industry will be productive and produce income for the next few decades.

Industry growth and upkeep: Will there be more jobs in the future? What types of industries will need to come to the region to support the main initiative? This will reveal how the industry can grow over time. This will also estimate how the introduction of peripheral industries could influence the economy and population of the region in addition to the main initiative. This is important to understand because this allows for further research to be done on what peripheral types of industries could be recruited in the area.

Job range: What types of jobs will be needed? This will tell us the varying levels of workers and also gain insight into where these workers could be pulled from.

4.2.2. *Explanation of Social Parameters*

Social			
Initiatives	**Local Stakeholder Opinions**	**Community Acceptance**	**Community Disparities**
Data Centers	Potential population growth	Yes	No
Copper Mining	Potential population growth Experiencing pollution and traffic	On average no	The community overall does not seem to want this option
Tourism	Opportunity for more income to come into communities	On average no	Variable, some want tourism, some want a more skilled job

Table 3: Criteria table with annotations

The social parameters we included are used to provide a quantitative analysis of qualitative factors (table 3). The structure of the decision matrix allows for the data we collected during our interviews to be well defined and easily understood. Since our results will be presented in a decision matrix and expanded upon in our report, the information gained from our interviews allows us to easily compare the different industries using a standard form or ranking; the report allows us to expand upon our interview findings and allows us to demonstrate analysis and other trends.

Local Stakeholder Opinions: How does the industry affect the community? How will the industry impact population growth? How would the industry affect local resources in the area? It's important to understand how the industry impacts the local population and their livelihood.

Community Acceptance: It is essential to know how people within the community perceive the different industry options. How does the public feel about the different industries? Does the community seem receptive to the industry?

Community Disparities: It is important to know why the community may not like the industry. Why are they concerned about the industry? Is there controversy among the community? Or does the community feel the same?

4.2.3 *Explanation of Environmental Parameters*

Environment					
Initiatives	**Resource Use**	**Environmental Impact**	**Climate Change Dependency**	**Types of Energy Use**	**Rare or Toxic Materials**
Data Center	During construction many resources are used, during operations lots of solar energy will be used	Solar panel life cycles impact environment, computer manufacturing is also not very green	World relies heavily on it, so it is probable that it will have to adapt to climate change	Plans to use renewable energy only	Uses rare materials for computer boards and servers, becoming increasingly scarce and expensive
Copper Mining	Large amounts of energy and oil to operate machinery	Toxic materials and heavy metals in large heaps around the industrial region, large holes in the ground distributing natural land, and contamination of local food sources	Most likely yes; rising temperatures would be the main issue in the region cause by climate change	Non-renewable; focuses on oil and gas usage	Yes; Heap leaching, a very destructive process, is used to extract the copper. Copper extraction can result in heavy metals and toxic chemicals
Tourism	Mainly natural resources, such as land area and water, along with other resources such as energy	Impacts include soil erosion, increased pollution, water pollution, natural habitat loss, wildlife endangerment.. However, tourism in the region has the potential to protect the environment; see Timna Valley national park	Depends; rising temperatures can be uncomfortable	Could use renewable or nonrenewable, depends on type of tourism, Most likely would be renewable due to the push for renewable resources in the region	Most likely not; Depends on the tourism industry. Certain industries don't produce toxic waste (ex. nature reserves), however some tourism practices do produce harmful chemicals as a result

Table 4: Summarizes environmental criteria

The environmental beauty of the Arava region is an important asset for the resident communities. With global warming becoming an increasing issue in the region, there is a focus on sustainable development that includes environmental protection. Several previous initiatives have been rejected due to a lack of environmental concern; it is essential to understand the environmental impacts of each initiative (table 4)

Resource Use: How many resources does this industry consume? What resources are needed to create this industry? These questions are important to ask because the region has a limited amount of resources available, if an industry needs more resources than available it will be very difficult for the industry to be successful.

Environmental Pollution: Does this industry produce pollution? What is the carbon footprint of this industry? The environmental impact of the industry is an important aspect to consider. Communities surrounding the area have mentioned their concerns about air pollution in the area, this information will better inform us how the industry may negatively impact the health of the ecosystem and communities in the area.

Climate Change Dependency: Will this industry survive changing temperatures? Will this industry survive the change in weather? Will this industry survive the increase of severe weather? Due to global warming, the average temperature of the Earth continues to rise. On top of hotter temperatures, severe weather and flooding will become more common. It is important to consider the ability for industries to adapt.

Types of Energy Use: What kind of power does this specific industry consume? Does this industry use renewable or nonrenewable resources? Energy usage is an important aspect of these initiatives. Solar energy is very popular due to the large amount of sunlight in the region, however this could cause potential issues when the sun is not present; this issue must be adequately addressed if an initiative plans to use only solar panels. If an industry needs a difficult to get type of energy it may be more difficult for the industry to become successful and fit into the region seamlessly.

Rare or Toxic Material Use: Does this industry consume precious materials? Does this industry consume toxic materials? How does this industry deal with disposing of these materials? Is the use of these materials safe? The use of toxic materials is an important concern due to the close proximity to various water sources and communities. This is an important consideration for the council as a matter of safety. Rare materials that may be necessary for the industry to operate also may pose an issue long term. The hope is for an industry to last for decades, however if the industry relies on a resource that is disappearing with no alternative it may be difficult for the industry to survive long term.

4.3 Decision Matrices

	Economic										
	Salary	**Employment Numbers**	**Revenue**	**Workforce Base**	**Workforce Training**	**Education**	**Future Demand**	**Industry Growth**	**Industry Upkeep**	**Technology Adaptability**	**Job Range**
Data Center	High	Low	High		High	Low	High	High	High	High	High
Copper Mining	Medium	High	Medium		High	Low	High	Medium	High	???	High
Tourism	Low	???	Low		Low	High	Medium ??	Medium ??	Low	???	Low

Table 5: Economic decision matrix

	Social		
	Local Stakeholder Opinions How does this proposal impact the local population?	**Community Acceptance** Does the community seem receptive to the introduction of this industry?	**Community Disparities** Does the community seem **NOT** receptive to this introduction of this industry?
Data Center	Medium	High	Low
Copper Mining	High	Low	High
Tourism	Low	Medium	Medium

Table 6: Social Decision Matrix

	Environment				
	Resource Use How much energy, water, and other resources does the industry use daily?	**Environmental Impact** Is there any pollution created by the industry or product?	**Climate Change Dependency** Can this industry survive climate change?	**Type of Energy Use** What types of energy can be used? Renewable? Non renewable?	**Rare or Toxic Material Use** Does the process use any rare materials that could become scarce in the future?
Data Center	Medium	Medium	High	High	Medium
Copper Mining	High	High	Medium	Low	High
Tourism	Low	Low	Medium	High	Low

Table 7: Environmental Decision Matrix

We completed our decision matrices using the information in our criteria tables in the previous section (table 5, table 6, table 7). Each column was ranked based on the criteria, for example salary was divided into high, medium and low based on the average salary for workers in each initiative. Tourism employees usually make minimum wage, meaning that it was ranked low, data center employees earn a high salary so they are ranked high. After all columns were ranked, colors were given to each cell based on what would be best for the region based on their values and goals. An example is seen in the revenue column (table 5), the region wants a high revenue industry, so the high category is green signifying that it is the best for the region. Another example is in the resource use column (table 7), the lower the resource use the easier it is on the ecosystem and local grid to support it, meaning that low is green because it is the best option for that criteria. Any gray cells signify that we do not have enough information to understand if this initiative would fit the goals of the community, this could be due to low sample size, missing data, or other constraints we faced while completing this project.

These matrices represent the data we have collected in a visual medium, allowing for the regional council to understand the positives and negatives of each initiative. Our criteria are only a small portion of the necessary information, but they allow a more focused start for the Eilot Regional Council to continue their research.

4.4 Community Interviews

Common themes that arose in our interviews were population/regional growth, environmental and economic sustainable development, and community values. These themes relate to the three proposed initiatives. If either one of these proposals were to be selected and implemented, it is important to be aware of the requests and concerns of the community.

One community focus is population growth. They emphasized that the region is very far removed from the central population of Israel. Challenges that come with being remote are the

adaptation to living in the desert and separation from family. With the exception of one, these communities expressed enthusiasm in growing their individual communities, some at different rates than others.

When discussing the proposals on the table, virtually all five communities shared their urgency in preserving and sustaining the environmental and economic development of the region. Following up on the aspect of being remote, the communities all share a core value of maintaining the treasure which they call the ecosystem of the Timna Valley. The communities believe that keeping the environment intact is a method of success that will ensure the sustainability and development of the region.

As mentioned above, the communities share common interests and values, one of which being how essential they view the ecosystem of the Timna Valley to their growth and success. They only want to flourish economically and socially if the environment keeps the value it has had for thousands of years. Along this, another value they mutually agree on is the importance of quality of life. Challenges arise with the ambitious goal of living in the desert, and with this they stress that it should be done in a way enjoyable to all where they can reap the benefits this region has to bring. Education and overall social growth is yet another value that they believe will encompass a successful community. Recently, these communities have started to include younger families for this exact reason, the new generation will be the future leaders and their values and teachings will be embraced within these communities.

After analyzing that these communities hold the same priorities and values, discussing the proposed industries that are on the table is crucial to assist these communities achieve their dreams and goals.

5. Discussion

5.1 Interpretations

The data center proposal, as stated above, is projected to have a workbase of local and national workers. (Stark, 2022). This indicates that these workers will move into the region. The same can be said about the mining proposal, and tourism focuses on attracting outsiders which will use the guest houses the communities have established.

If renewable energy were to be implemented with the data center proposal, this would bring some environmental sustainability that these communities have requested. Comparing the expected salaries and revenues between proposals, the data center initiative is expected to bring the most for the workers and communities. (CTech, 2021 & Stark, 2022). Expanding tourism would bring more awareness on the importance of preserving the natural ecosystem as is but does not seem to benefit the environment. Mining would affect the environment the most due to the processing of copper ores and chemicals included. (Ghorbani et al., 2016).

Quality of life is an unanimous value every community member interviewed expressed. They hold the necessity for a happy life and success in the desert. Community member B expressed that the future, whether it be ten years or twenty years, will be led by the younger generations whose values and education will lead the communities towards a brighter future. The tourism industry will always be able to highlight these necessities and can bring in members who hold the same values. The mining industry can only bring so much in terms of enhancements of living conditions, work force, and wages. (Mining Engineer Salary in Israel, n.d.).

5.2 Implications

The data collected across our project allows for a broad overview of the different potential initiatives with a focus on sustainability. Our results provide an organized set of information that allows for an easy comparison of the different potential initiatives at stake. This allows for the council to better understand the various impacts of each industry using both qualitative and quantitative data. Our work has set the foundation for further research into the initiatives. The work we have done could help guide the Eilot Regional Council to make a decision that is balanced between economic, social, and environmental sustainability.

5.3 Limitations

The data we collected from our interviews only represents a small portion of community perspectives in the Eilot region. This is significant because our results are merely a sample of the local population; these results are not representative of the local population. Due to this, we cannot draw generalized conclusions from our data, we are only able to draw conclusions about the different needs of these specific Eilot community members .

Additionally, portions of our decision matrices are not completed due to a lack of available resources and a lack of knowledge. For example, several of the economic criteria in the decision matrix are specific to the Eilot region in Israel, however much of this data is not recorded or is not made available to the public. Due to this, there is missing information in our decision matrix. Some of these grayed cells may still have information present, but these cells are assumptions based on various information not directly related to the Eilot region.

Another limitation we encountered was personal biases. Much of our information was gathered through interviews. Through these interviews we gathered two types of information: community perspective and industry estimates. We use much of these industry estimates in our final deliverables, however we recognize these values may be overly optimistic and may not be fully optimistic or not represent the full picture.

5.4 Recommendations

For future projects in the industrial site of Timna, it is important to focus on rehabilitation for the region. Currently in the industrial region there are piles of toxic materials and heavy metals, large creators, and scattered remnants of an abandoned copper mining industry. Additional research should be conducted on what can be done with toxic waste found in Timna, and how to rehabilitate the environment from the years of damage from different industries in the area. The Eilot Regional Council should next develop plans to set rules and standards for industries that would use the industrial site to better protect the environment there. These regulations could include limits on pollution, energy use, and rules to maintain the environment in a healthy state.

Further research would also need to go into maintaining initiatives such as green technologies. As learned from the interviewees, the surrounding communities are greatly concerned with the environmental effects of the proposed initiatives. The most common green technology in the Eilot region are solar panels, most communities utilize the technology since the area receives many hours of sunlight. It is worth researching the benefits of incorporating these solar panels with the data center proposal as it could make this initiative more green. The data centers would receive power from this renewable energy which has been reported to be very desirable with the surrounding communities in the Eilot region.

6. Conclusion

The Timna valley is located in the Arava region in southern Israel, and is home to large copper deposits. Throughout modern and ancient times, these deposits have been mined to produce copper. The remnants of the closed modern copper mine pose threats to the environment due to the lack of remediation. Additionally, these modern copper mines have no value to the surrounding communities. Initiative research discussed in this proposal shows how harmful waste products from copper mines can truly be; this demonstrates, not only the need for the remediation of the land, but also the need to diminish environmental and chemical harm.

The current mine transformation techniques that are practiced in various hard rock mines around the world have provided crucial information about the potential the Timna Industrial Area holds. Incorporating local perspective and industry knowledge will enable us to present information regarding each potential industry interested in the Timna Valley mine. We expect our methods to yield results that will be able to assist and guide the Eilot municipality about the effects of each proposed solution. This will allow the Eilot council to better understand each industry interested in the development in the Timna Valley mine.

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8. Appendices

Appendix A: Community Interview Questions

1. Can you explain a little bit about your community and its population?
    a. Is your population growing or shrinking?
    b. What would you say is a core value of your community?
    c. Where would you like to see your community in 10 years?
2. Do you care more about an industry bringing in money? Reflecting the culture of the area? Or protecting and maintaining the natural ecosystem?
    a. Could you explain your reasoning?
3. Under what terms would you accept a new industry in the area?
    a. How would you feel about a growth in your community's population in a short amount of time?

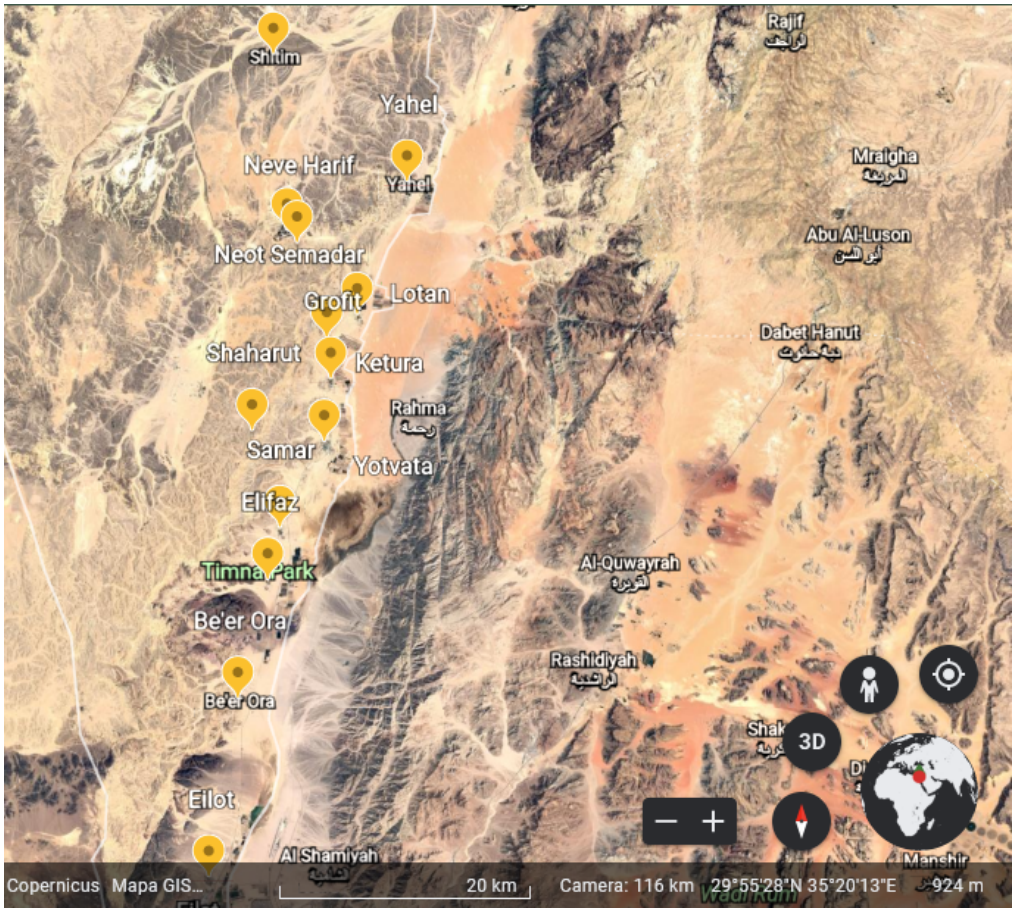
This was the question set that we used for our community interviews, these were in person or virtual interviews depending on the availability of the person. This allowed us to get insight into each person's values and beliefs.

Appendix B: Criteria Table and Decision Matrix

Decision Matrix

This is our spreadsheets with our criteria table and decision matrices. There are citations commented into the criteria table to better understand where our information came from. In order to keep the privacy of those we interviewed we have used interviewee to signify that we got that info from our interviews.

Appendix C: Map of Eilot Regional Council communities



This is a map with all the communities that are a part of the Eilot Regional Council. The green Timna Park label is roughly where the Timna Industrial Area is, this allows people to understand where in relation to the communities that the industrial site is.