Using GIS tools to build new main mine access

Authors:

• Arturo Morales Ladron De Guevara, senior geologist, specialist in Territorial Administration Sustainability Management. El Teniente, Codelco Chile.

• Ignacio Yáñez Henríquez. Civil Engineer in Geography. Company: Geoinfo.
Real Title:

“Using GIS spatial tools to asses better engineering options to build the new main access to the El Teniente Mine, Codelco Chile. Implementing GIS in the mining industry, some lessons”.
INTRODUCTION

• The El Teniente copper Mine is located in central Chile, Lat 34° 08S, Long 70°35W, about 2000 m.s.l, and is actually starting to design and construct the future underground mine, called “New Mine Level Project” in order to sustain and increase the actual production rate of 141 ktpd, exploiting total proven reserves of 2300 MTon of 0,86% average Cu grade for the next 50 years.

• The issue dealt in this paper is to highlight the usefulness of GIS technologies in the ArcGis 10 platform to analyze the designs offered to contractors to build the access roads and workplaces and facilities for heavy equipments in order to build a brand new access of 18 km to the El Teniente Mine, worth 400 MUSD.
Mineral extraction, 140,000 tpd
Avg. 1% Cu Total

Main actual mine entrance: Adit 71

Mineral process plant, Crushing-Milling and Concentration 3800 tpd

Caeltones Smelter
Metallic copper 1100 ton fine Cu day

Final tailings deposition dam (actual 871 MTon tailings)

Tailings facilities (86 km long channel) 138,000 tpd,
2 m3/s: 45% water/55% crushed rock

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Territorial location of the El Teniente Division

Main mine facilities

Interaction with:
3 Regions
18 Municipalities
800,000 inhabitants

87,000 Has of surface property
What`s the problem to be resolved?

The problem detected is that the preliminary maps used to design these works were done using only a Google Earth image plotted in a Local Topographic Map.

Since the topography in this part of our territory is mainly characterized by undulating hills, nearness to a big river, steep slopes at some places, native vegetation and several creeks crossing the lay-out, we detected that there would be critical problems for the contractors to decide for themselves the better construction option, considering that for environmental and safety reasons some of this places were very fragile.
What`s the solution used?

The solution adopted was to use existing aerophotogrammetrical, high-resolution Lidar technology to better represent the landscape involved and to analyze the access roads and facilities to be emplaced resulting in highlighting 44 territorial “warnings” to improve the layout and for better use of existing gravel paths and vegetation free zones.

Also one of the dimensions that were taken into account was the existence of neighboring territories that weren’t Codelco’s property, so we discovered using a multiring buffer analysis a vulnerability that the decisions takers has to resolve.
Zonification of the sectors analyzed, presently bare land
Zone 1, near the Caletones Smelter
Zone 2, in front of the currently used industrial waste dump
Zone 6, near the property surface boundary
Project: New main mine access, general view using ArcGIS .10
Results territorial analysis

Table 1: summary of total calculated path km by type and pre-existence

<table>
<thead>
<tr>
<th></th>
<th>Existing path (km)</th>
<th>To be constructed (km)</th>
<th>Total (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Path</td>
<td>23.98</td>
<td>7.00</td>
<td>30.98</td>
</tr>
<tr>
<td>Crosses</td>
<td>0.00</td>
<td>0.64</td>
<td>0.64</td>
</tr>
<tr>
<td><strong>Total (km)</strong></td>
<td><strong>23.98</strong></td>
<td><strong>7.63</strong></td>
<td><strong>31.61</strong></td>
</tr>
</tbody>
</table>
Results territorial analysis

Table 2: summary of territorial warning zones

<table>
<thead>
<tr>
<th>Territorial warnings</th>
<th>Z1</th>
<th>Z2</th>
<th>Z3</th>
<th>Z4</th>
<th>Z5</th>
<th>Z6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tailings channel cross</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Cross with natural drainages</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td>Zones of slopes</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Vegetation zones</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Zones near surface property boundaries</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
<td>8</td>
<td>8</td>
<td>5</td>
<td>2</td>
<td>8</td>
<td>40</td>
</tr>
</tbody>
</table>
Logical Functional Model of El Teniente GIS

El Teniente Division

User Clients

Informatics

Strategic Administration

Expert Support

Web Clients
Conclusions

The usefulness of GIS technologies to better represent the territory and its variability, is used to improve the engineering approach to build a new main access (highway and tunnels), making possible to avoid risks and delays therefore implementing better construction solutions.

All this GIS work is been integrated into a solution based on the latest ArcGIS 10 platform in order to deal with several areas of responsibility in our company as: water, road and electrical facilities and infrastructure, 87 km long tailings channel, deployment of projects into the territory to handle multi-user competency of it and sustainability issues as: environmental targets, community relations and interactions with our activities and how state planning instruments affect our projects. The main lesson learned from this 2 year effort is to engage the top managers in supporting this work and to identify leader users in the different departments that can stand and respond for the information gathered in our GIS.