GROUP

05

WATER AND ENVIRONMENTAL SUSTAINABILITY

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MISSION

The group's mission is to develop basic knowledge and technologies that allow to foresee and mitigate mining activities' impact on air quality, ecosystems and human communities. The group seeks to develop predictive models of technological and natural systems behaviors. It seeks to determine the degree of environmental sustainability of the mining industry considering both operation and closure phases. The models include works of the hydrologic systems serving as source of superficial and underground water for mining, physical-chemical mechanisms, which determine the behavior of aquatic ecosystems, and applied science for design and optimal operation of engineering systems with intensive use of water.

TEAM

Principal researcher:
- Yarko Niño, PhD.

Associate researchers:
- James McPhee, PhD.
- Aldo Tamburrino, PhD.
- Andreina García, PhD.
- Santiago Montserrat, PhD.
- Miguel Lagos, MSc.
- Leonardo Navarro, Geologist.
- Álvaro Navarrete, Geologist.
- D. Alexis Caro, Geographer.
- Yurieth Quintero, MSc.
- Gerardo Zegers, MSc.
- Felipe Saavedra, Ing.
- Alex Garcés, MSc.
- Tomás Gómez, Ing.
- Barbara Rodriguez, PhD.
- Vania Rojas, PhD.
- Yurieth Quintero, MSc.
- Maibelin Rosales, Ing.

Post doctorate researcher:
- Bárbara Rodríguez, PhD.

3 PhD students

4 MSc students

FIELDS OF EXPERTISE

- Integral study of hydric resources in high mountain areas.
- Climate change studies.
- Transportation and traceability of contaminants in aquatic systems.
- Flux modelling of non-Newtonian fluids on real topographies: landslides, floods, avalanches and tailing dams breaking.
- Development of nanotechnologies for water treatment.

PROJECTS

1. MINE PLANNING UNDER HYDROLOGIC UNCERTAINTY

Fundamentals

Water availability in short-, medium- and long-term influences the mining planning and operations. In short-term, extreme hydro-meteorological events (landslides, floods, tailing dams overflow) can interrupt operations and damage infrastructure. Water availability in short- and medium-term influences design and planning, while long-term availability (climate change) can generate uncertainty.

Goals

- To develop forecast tools incorporating medium and long-term hydrologic risk into mine planning.
- To acquire remotely and automatically interpret relevant information related to hydrology (MODIS, Landsar, Cloudsat, etc.).
- To develop and design sensors´ networks for hydro-meteorological monitoring and alert.
- To incorporate the hydro-meteorological forecast tools into mine planning models.

Results

- Decision tool for mine planning in hydrologically uncertainty conditions, considering interaction with communities within the context of higher demand and lower water availability.
- Computerized modeling tools for decision-making.

Team:

James McPhee, PhD. Yarko Niño, PhD. Aldo Tamburrino, PhD. Santiago Montserrat, PhD. Nelson Morales, PhD. Miguel Lagos, MSc. Felipe Saavedra, Ing. Alex Garcés, MSc. Tomás Gómez, Ing.

PROJECTS

2. TRANSPORTATION AND TRACEABILITY OF CONTAMINANTS IN AQUATIC ENVIRONMENTS

Fundamentals

Water quality depends on basin's natural conditions and nearby anthropic activities. The industry can also add a series of contaminants and worsen the water quality. In Chile, it is not unusual to see high concentrations of heavy metals and metalloids associated with natural leaching processes of mineralized rocks; their presence is often attributable to mining activity.

Goals

- To develop modelling tools for transportation and decay of heavy metals in superficial water bodies.
- To predict changes in the quality of superficial waters due to mining activity and/or hydrologic long term changes.
- To gather and interpret point- and continuous field data in hydro-chemistry, hydrology and sediment transport

Results

- Hydro-dynamic numeric model: 1D and sediment transport in superficial water bodies.
- Hydro-chemical model for metallic contaminants speciation.
- Coupled model (hydrodynamic-hydrochemical) of transportation and decay of metallic contaminants.
- Physical-chemical characterization of superficial water bodies. Numeric modelling and field data analysis.
- Evaluation of water quality according to regulations.

Team

James McPhee, PhD. Yarko, Niño PhD. Andreina García, PhD. Santiago Montserrat, PhD. Manuel Caraballo, PhD. Miguel Lagos, MSc. Edward Cornwell, MSc. Tomás Trewhela, MSc. Leonardo Navarro, Álvaro Navarrete, Alexis Caro, Gerardo Zegers, MSC.

3. DEVELOPMENT OF TECHNOLOGIES BASED ON NEW MATERIALS FOR MINING-ASSOCIATED WATER TREATMENT

Fundamentals

Water shortage, superficial water bodies contaminated by natural or anthropic ways, massive use of seawater and need for desalination plants are important problems that the mining industry must face. Therefore, the generation of new water-obtaining technologies for industrial use, and the problems these treatment processes imply, are part of the challenges of this project.

Goals

- To develop new technologies for detoxification of polluted waters (arsenic) using nanomaterials and sunlight.
- To develop new technologies based on ultra-filtering or reverse osmosis membranes for desalination of seawater desalination.

Results

- Construction of a prototype equipment for arsenic removal in water based on nanomaterials and sunlight.
- New polymeric membranes with anti-biofouling capacity for seawater desalination.

Team

Andreina García, PhD. Santiago Montserrat, PhD. Bárbara Rodríguez, PhD. Yurieth Quintero MSc.

Cooperation with other organizations:

- Physics Department, University of Cali, Colombia.
- Nanotechnology and Materials Engineering Center, IVIC, Venezuela.
- Ecolab-Nalco research center, Brazil.
- Centre of Nanoscience, Trinity College, Dublin.

4. NUMERIC SIMULATION OF WALL BREAKING IN A TAILINGS DAM

Fundamentals

Worldwide, tailings dams' failure rate (about two events a year) is higher than water dams'. In Chile, during 1915-2010, more than 38 events occurred. These failures have dire environmental consequences, many times with loss of human lives. They are associated with the flood of tailings downstream from the dam; the flow depends on the manner the wall fails and how the generated breach evolves. Worldwide, the most common failure mechanism is erosion due to floods above the wall. The situation in Chile is different since the main cause is "flood failure" caused by seismic events, which can be accompanied by flood over the wall. Flood monitoring parameters, such as, the volume of fluid that is susceptible to flowing in case of failure and its temporal distribution constitute fundamental information to model the downstream effect of the dam failure.

Goal

- To determine a failure model proper to the geometry and typical conditions of Chilean tailings dams.
- To develop and apply a flow model that considers the non-Newtonian nature of the flooding fluid and the failure breach's erosion.
- To determine poured volumes and their temporal distribution for a typical Chilean tailings dam.
- To implement a breach generation model and a tailings hydrogram model in a computer platform that allows its application to typical dimensions and components of a Chilean dam.

Results

- A computer platform capable of incorporating the typical geometries of a Chilean tailings dam.
- A numeric model that allows determining the evolution of a seism-generated breach on a tailings dam.
- A numeric model that allows determining the flood's flow through a breach on the wall, considering time, the tailings' characteristics and that can work as an input for flood monitoring models.

Team

Aldo Tamburrino, PhD. César Pastén, PhD. Aldo Muñoz.

Cooperation with other organizations:
Structures and Geotechniques Division, Civil Engineering Department, University of Chile.