



## **Solutions for Mining**

How topotubes can provide you with security and lower costs.

Tailing Dams  
Barrier Protection  
Monitoring

# Introduction

## Tailing dams requirements

Tailing dams are used to contain mining waste. They often belong to the largest dams and structures in the world and must stand in perpetuity. Experience has shown that dam failures causes extensive environmental damage with huge clean-up costs. This consideration should be incorporated in the dam design, especially with regards to hydraulic and seismic events that might effect the dam.

There are three leading causes for tailing dam incidents (ICOLD 2001): Overtopping, slope stability failures and earthquakes. Often failure mechanisms are attributed to cumulative effects (e.g. internal dam erosion, static losses due to seepage, multiple earthquakes, landslides,...).

The opportunity to improve the present system of tailing dams is the reason for topocare to transfer our knowhow to the mining domain.

## Topocare and topotubes

Topocare is a leading technology company in the field of new and secure dam designs. Founded to develop machines which can build stable and long term secure levees and embankments in hydraulic engineering, topocare is expanding its technical solutions to other branches.

The core of the topocare construction method are topotubes, which are sand and soil filled geotextile tubes. These tubes have the advantage of a composite structure and thus have better characteristics in terms of erosion control and form stability which directly address the problems mentioned above regarding tailing dams.

Conventional failure mechanism such as static failure due to seepage, scouring or outer erosion are prevented. Hence dams can be built which withstand overtopping, slope failures or other forces such as wave attack. Additional digital monitoring systems assure a safe operation of the dams.



Reference:  
ICOLD 2001: Tailing Dams: Risk of dangerous occurrences. Lessons learnt from practical experiences, ICOLD Committee on tailing dams and waste lagoons, Bulletin 121, 2001.

# topotubes

## Geotextile tubes

### Superior dam characteristics

- Erosion stability
- Use of variable geotextile due to requirements
- Flexible stabilization
- Prevention of many conventional failure mechanisms

### Cost savings

- Smaller dam footprint as a result of higher stability
- Less filling material needed (soil, sand,...)
- Harnessing locally available soil material

### Construction technology

- Formation of the tubes directly on site, no extra processes
- Minimal construction times
- Consistent quality of construction due to automated tube laying process



# topotubes



The picture shows the topotube dam from the topocare test facility.



A geomembrane ground layer is used as a base for the pond.



Different test scenarios were undertaken to proof dam stability and safety.



Several layer of topotube create a stable dam body. A steep ankle can be realized.



# Machinery



## Equipment

### Tube laying technology

A main focus of the company is the construction of topotube laying machines. These machines are designed to build the tubes directly on site and address the special needs of different applications.

### topomover

The topomover is a construction machine, which is able to build dams, e.g. for tailing ponds. The main characteristics of the machine:

- Dry or wet soil can be used as filling material for the tubes
- Ability to build dams out of several layer of topotubes
- Highly efficient tube creating mechanism

### topopacker

- Formation of the tubes directly on site, no extra processes
- Minimal construction times
- Consistent quality of construction due to automated tube laying process



# Machinery



The topomover is a construction machine for producing and laying topotubes.



Equipped with robust conveyer belts the machine is able to process different materials.



The boom is fully variable to facilitate different dam designs.



The tubes are produced directly on site using our unique helix system.

# Monitoring

## Condition monitoring

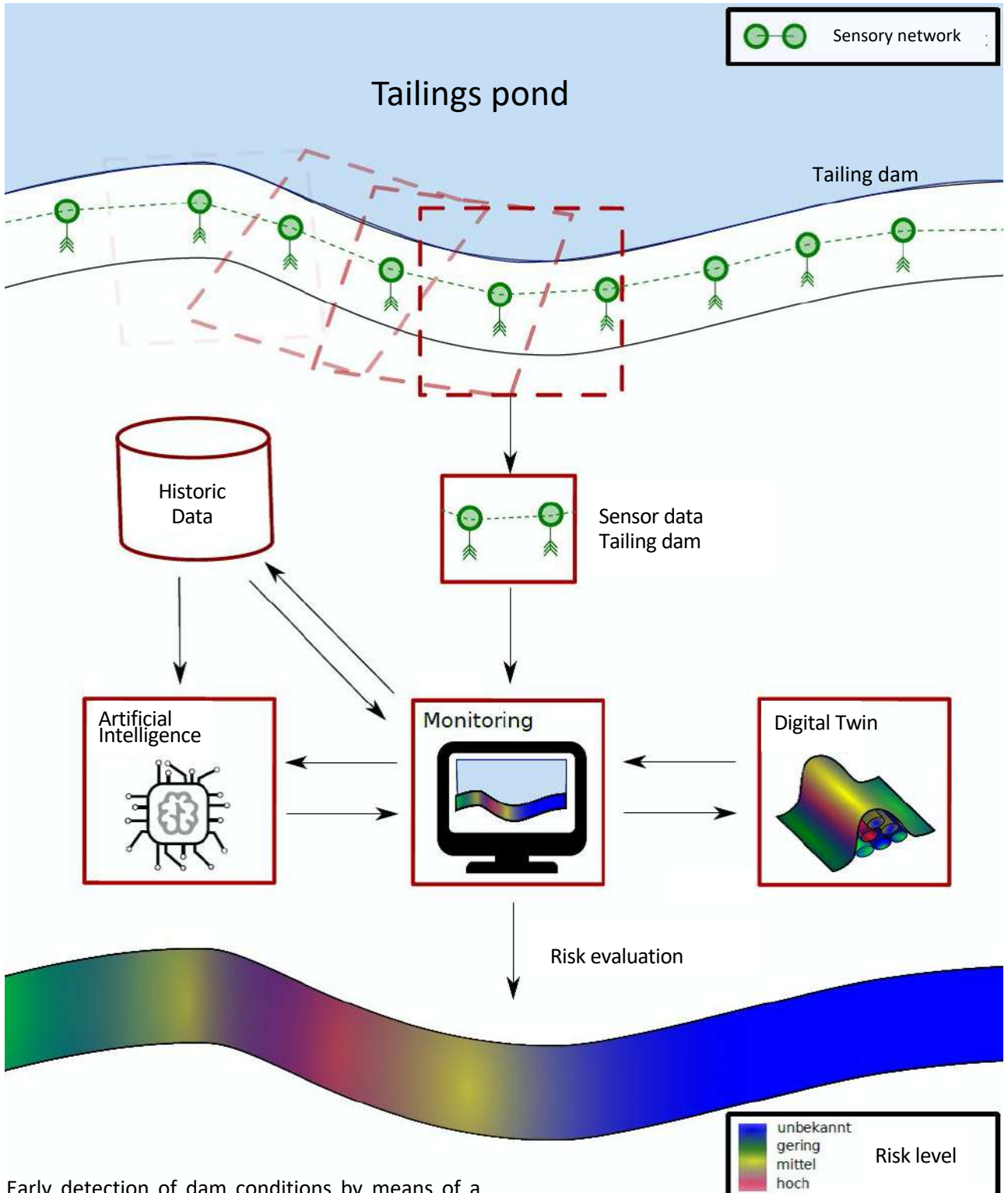
### Sensor technology

We have developed an innovative sensor system to detect dam conditions. The system detects displacements and seepage water within the structure and evaluates them on the edge by using AI algorithms.

### Dashboard

The data is evaluated and visualized. On the basis of this data, predictive actions for dam maintenance can be carried out. An early warning is given if there is a threat of overload and possible collapse of the dam structure.

# How the system works



Early detection of dam conditions by means of a digital dam image.



# Applications

## Solutions for mining

### Tailing dams

In the following pages the integration of topotubes in tailing dams will be shown. There are different applicable areas which will be highlighted:

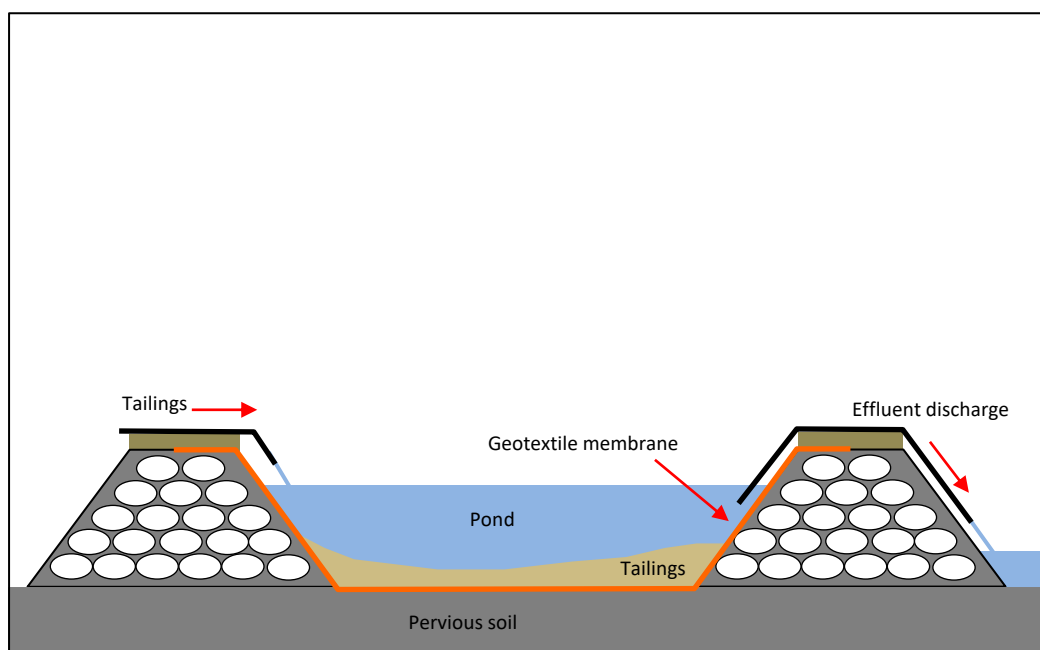
- Capacity increase
- Stabilization
- Primary barrier protection

### Other Applications

Also an overview of other interesting applications in regards of mining are presented:

- Disposal sites
- Drainage systems
- Solar ponds

# Tailing ponds



General design requirements of tailing ponds are that there is no seepage either to the side or into the groundwater. Failures as a result of dam seepage, scouring, erosion or even unintended overtopping have to be prevented. A time and cost efficient method is needed, which delivers a high security level which ensures dam safety over an extended period of time.

## topocare's solution

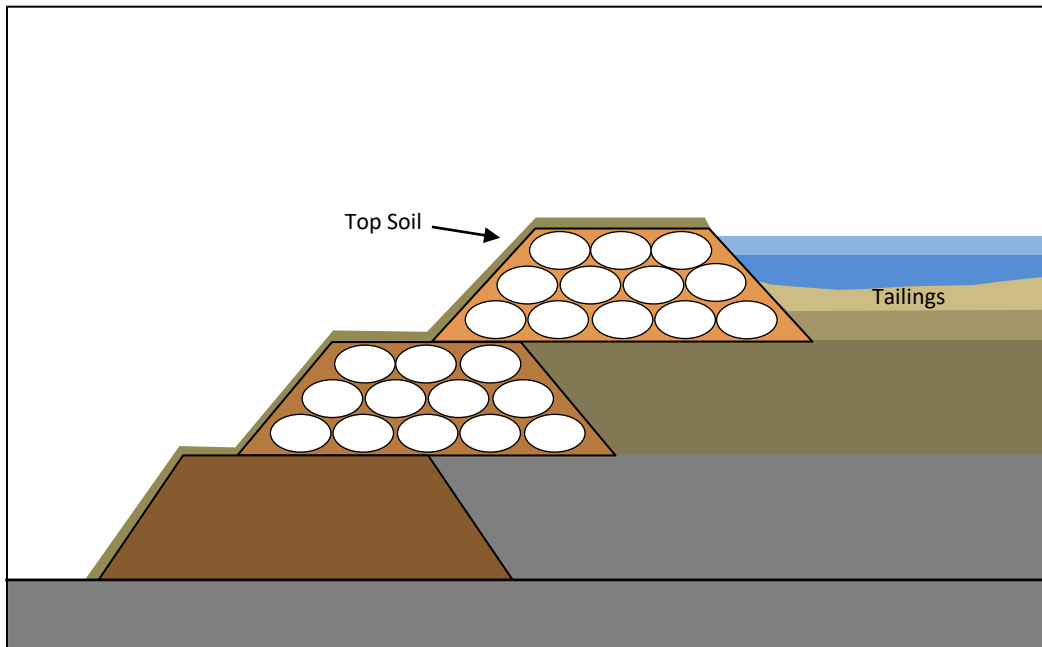
topotubes are presently used to construct embankments and levees for flood protection. This knowledge can be transferred into the mining domain. The picture above shows the use of topotubes in the construction of tailing dams. Specific solutions will be presented in the following pages.

### General Advantages:

- Stable dams with advanced stability characteristics
- Dams can be raised for a later capacity increase
- Tailings and other waste can be used as filler material for the tubes
- The encapsulation improves tailings mechanical characteristics
- Less space and material is required to build the dam
- Continuous monitoring can be applied to detected and problem solving
- Overall costs and environmental damages are reduced



# Capacity increase



Over the lifetime of a mine more and more material is filled into tailing ponds. As a result a capacity increase is needed over time. For this reason the dams have to be heightened without increasing the risk of a failure. Secure methods are needed.

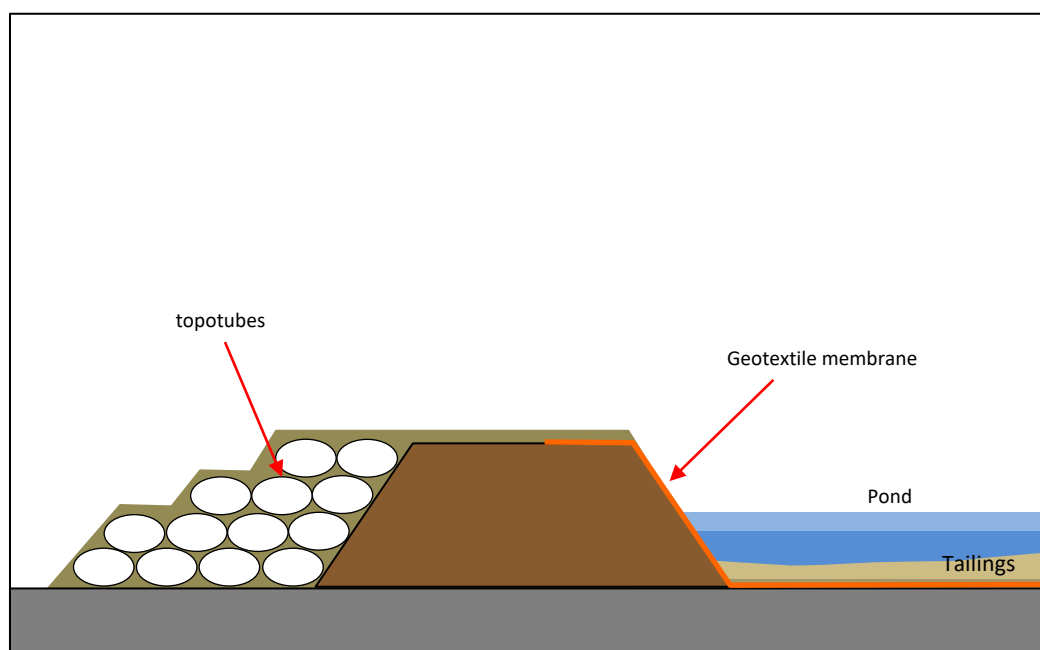
## **topocare's solution**

The existing pond can be used as a base platform for an vertical expansion. In this way a topotube dam structure is added upon the existing structure by considering the requirements for structural stability. Settled tailings can be utilised as filling material for the tubes.

## **Advantages:**

- Utilisation of waste material (tailings) to construct the embankments
- No expansion of the dam footprint
- Cost efficiency due to tailing fillings and limited site extension
- Environmental efficiency due to less transportation
- Stability increase and lowered failure risk
- Continuous monitoring can be applied to added dam sections

# Stabilization



There are many existing tailing dams which were built with outdated design and perhaps are no longer safe. Also vertical capacity increase can effect the stability of the lower dam layers. Thus the risk of damage or collapse increases over the time. Stabilization measures may be required to sustain it's continued use.

## **topocare's solution**

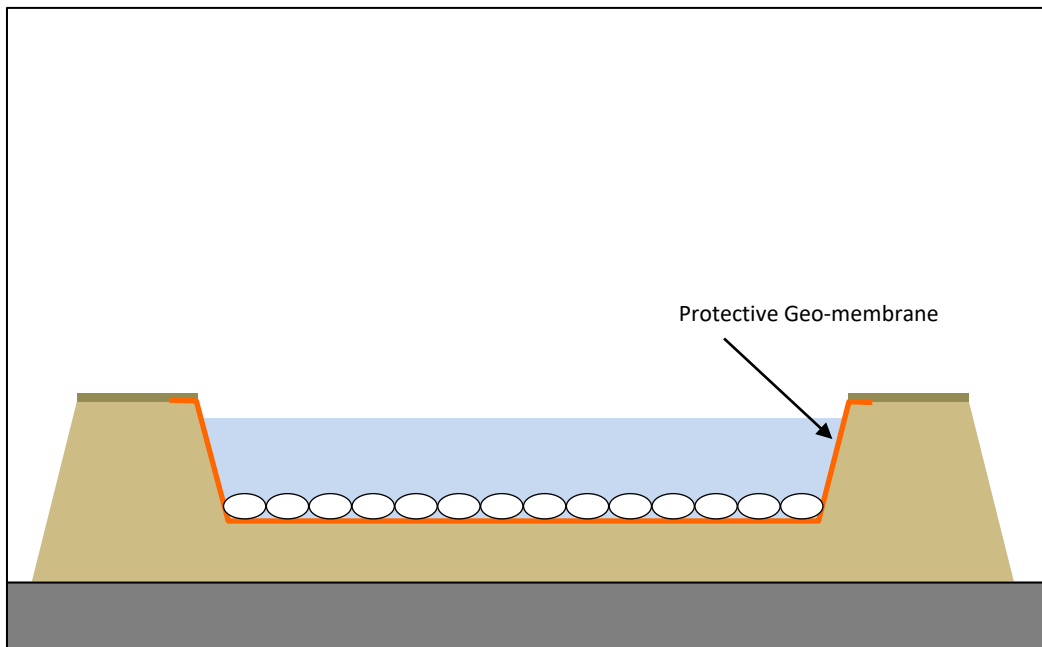
The old dam structure can be enhanced with topotubes supporting side stability. Failure mechanisms such as slope failures are interrupted when topotubes are placed at the right location.

## **Advantages:**

- Interruption of conventional failure mechanism
- The composite structure leads to higher stability levels
- Enhancement of old dam structures
- Cost efficient reinforcement method
- Continuous monitoring can be applied to added dam sections



# Primary barrier protection



A usual method to prevent seepage into groundwater is the use of a geomembrane as a barrier. It is critical for environmental reasons that this primary barrier remains intact.

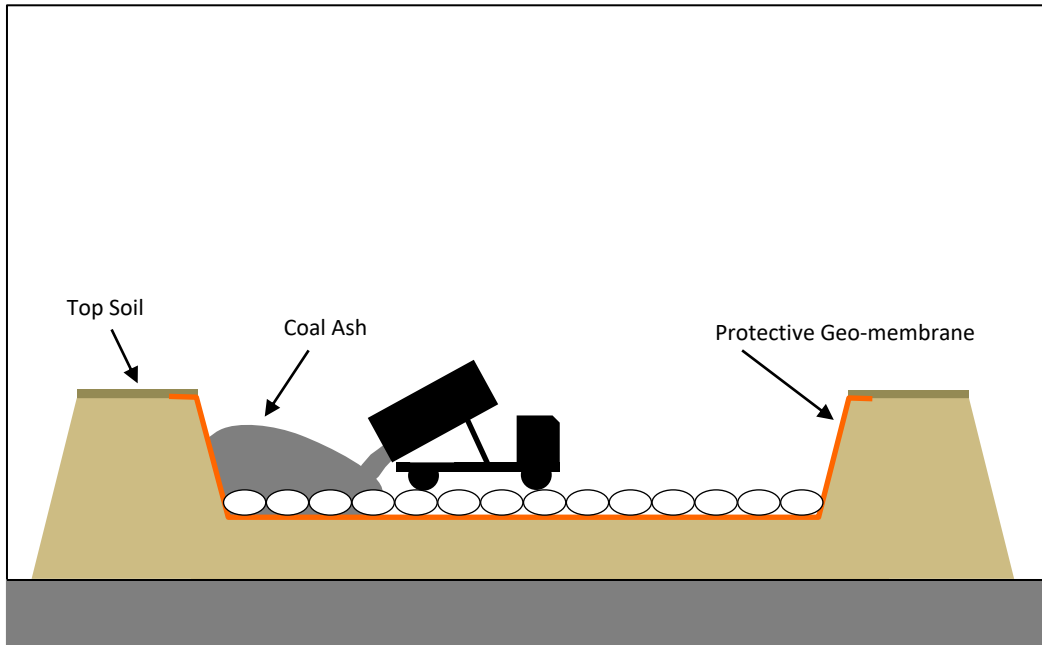
## **topocare's solution**

To enhance the protection level a secondary barrier out of topotubes can be installed on the top of the geomembrane to prevent possible damage.

## **Advantages:**

- Increased safety due to second protection barrier
- Higher liner integrity
- Meets high environmental standards

## Other applicable areas



There are other applicable areas for topotubes which are connected to mining. Some will be highlighted below.

### **Disposal sites** (e.g. coal ash)

topotubes are used as a secondary protection layer for the geomembrane:

- The membrane is protected from mechanical damage
- Even coarse material can be used as filling material (e.g. coarse ash)
- It will only be driven on the tubes, not on the primary liner.

### **Drainage systems**

A drainage pipe can be integrated within the tube. In this case gravel would be used as a filler material for the tube to support the drainage effect.

- Easy to install drainage system
- Good drainage effect

### **Solar ponds**

To create a pond system to serve as a large scale solar thermal collector topotube can be integrated into the design of the dams. Especially when there are inappropriate materials such as sand to construct the dams, topotubes can be a real advantage.

- Use of a wide range of materials
- Better land utilization due to smaller dam designs
- Erosion control





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