



Collaboration, Innovation and Resilience: Championing a Digital Generation

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# 3D Geological Modelling for Hydro Power Tunnel Drilling: Combined use of Generic GIS Tools and AI-Assisted Scripting

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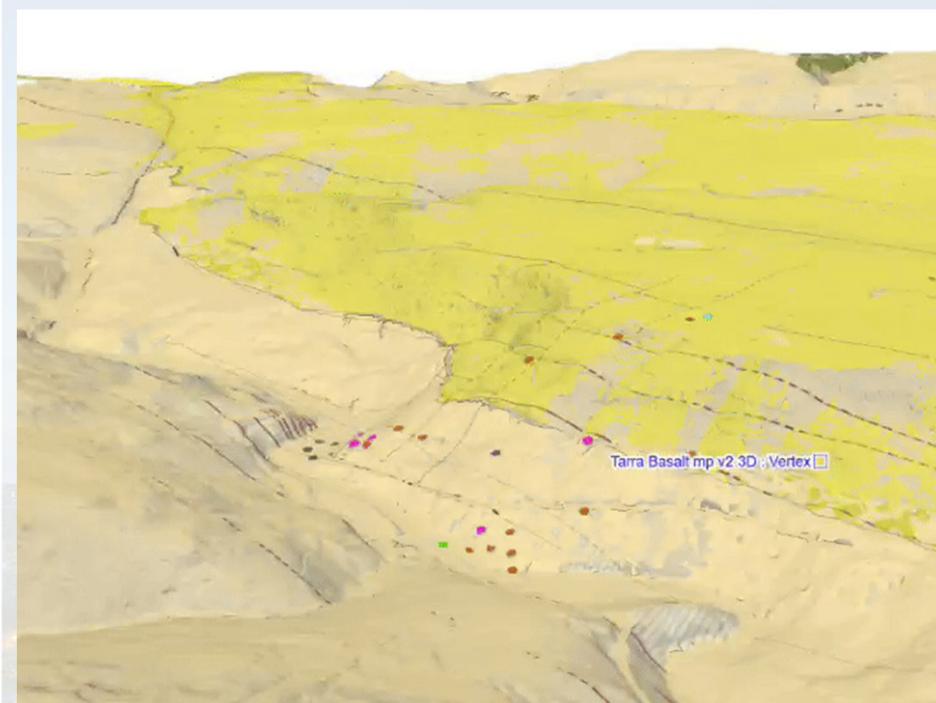


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## Context

- **Background:** Upgrading or exploring new renewable energy potential is crucial to achieving Australia's renewable energy targets
- Understanding the geology of the site from geotechnical drilling investigations is one of the most critical works in the construction of hydroelectric power generation.
- A key part to building the geological model lies in understanding the geological layers from borehole samples.

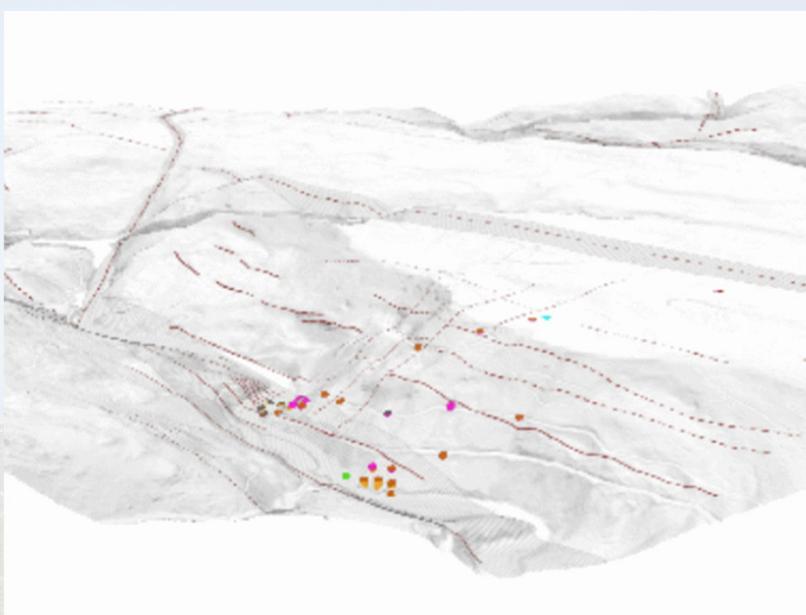




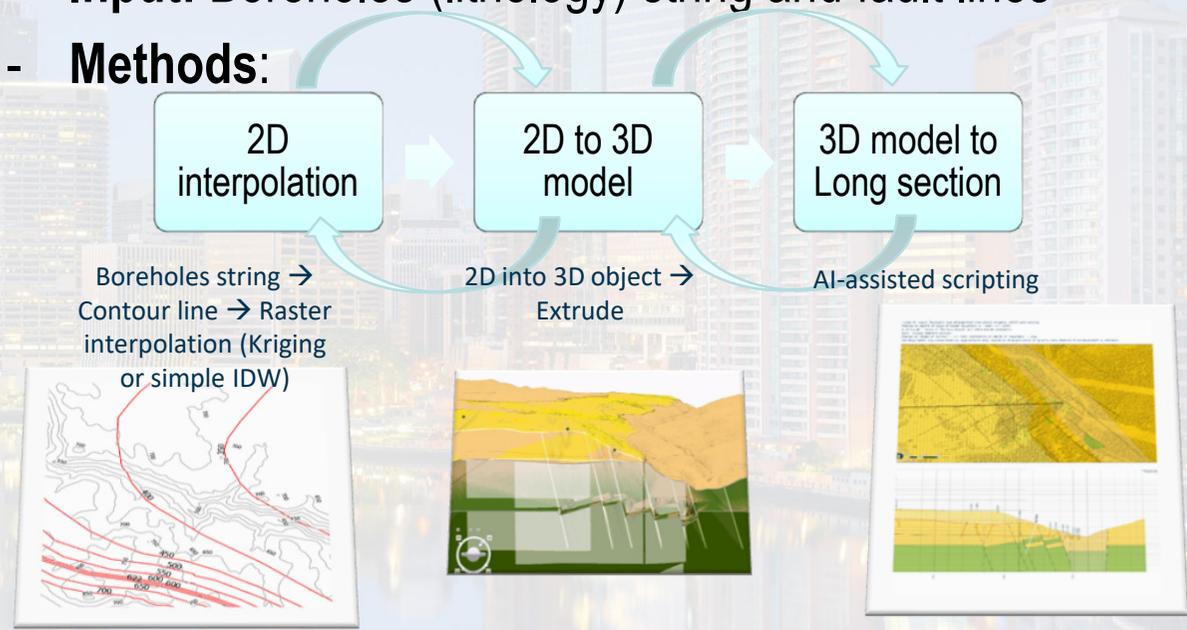
## Context

- **Background:** Upgrading or exploring new renewable energy potential is crucial to achieving Australia's renewable energy targets
- Understanding the geology of the site from geotechnical drilling investigations is one of the most critical works in the construction of hydroelectric power generation.
- A key part to building the geological model lies in understanding the geological layers from borehole samples.
- **Problem identification**
  - Cost of the additional geology software and training
  - Data integration with field data collection
  - Limitation on GIS platform
  - Knowledge gap on scripting
- **Objective:** Develop a 3D model to identify geological structures, enabling designers to create designs that best adapt to the underlying geological model

## Data input and method



- **Input:** Boreholes (lithology) string and fault lines
- **Methods:**



## From 3D model to long section

- Convert XYZ into Route (Chainage) and Z: Tunnel alignment, borsholes point location, lithology string, and faults
- Pseudo code:
  - Get the geometry of each layer [Chainage , z]
  - Convert [Chainage , z] into [x , y] geometry.
- **AI-assisted** scripting using ChatGPT
  - Question: “Create 3D polyline that preserves attributes from XYZ table”
  - Review and iterate ~ need script basic understanding
    - Grammatically correct script but result in error.
    - Not achieving objective: Re-write the question or input

```

# Create a new feature class for the output polylines
arcpy.CreateFeatureclass_management(arcpy.env.workspace, output_fc, "POLYLINE", input_table)

# Add ORIG_FID field to the output feature class
arcpy.AddField_management(output_fc, "ORIG_FID", "LONG")

# Open search cursor for the input table
cursor = arcpy.da.SearchCursor(input_table, ["ORIG_FID", "INSTR", "Layer", "GeoType", "Z"])

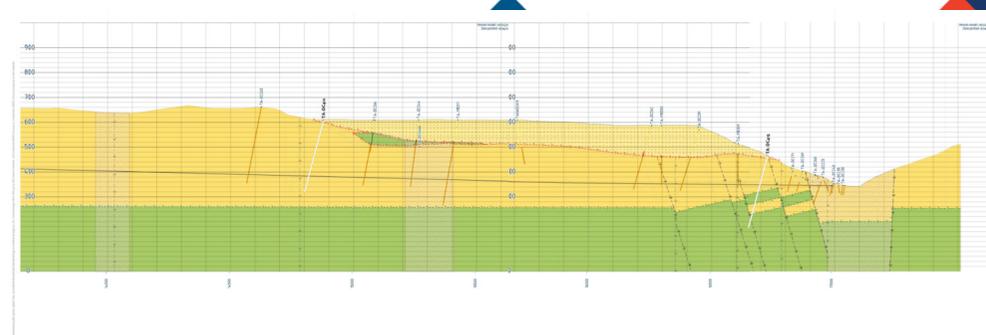
# Dictionary to hold points grouped by ORIG_FID
line_points = {}

# Read the coordinates from the table and group by ORIG_FID
for row in cursor:
    line_id, instr, geoType, z = row
    # If line_id not in line_points:
    line_points[line_id] = []
    line_points[line_id].append(arcpy.Point(x, y, lyr, geoType))

# Insert polylines into the output feature class
with arcpy.da.InsertCursor(output_fc, ["ORIG_FID", "Layer", "GeoType"]) as insert_cursor:
    for line_id, points, lyr, geoType in line_points.items():
        if len(points) == 2: # Ensure there are exactly 2 points for each ORIG_FID
            polyline = arcpy.Polyline(arcpy.Array(points))
            insert_cursor.insertRow([polyline, line_id, lyr, geoType])
        else:
            print(f"ORIG_FID: {line_id} does not have exactly 2 points and will be skipped.")

# Clean up cursor objects
del cursor

print("Lines created successfully")
    
```



## Take home messages

- The combined use of spatial analytical tools and AI opens opportunity to answer spatial question
- It speeds up the learning process and fill the knowledge gap
- The challenge would be to review/assess the answer produced by AI
- Limitation and future work:
  - Abrupt geological features such as raft or lens have not been considered in this model
  - To make a smoother automatic process from the input to long section
- AI-assisted scripting closely coupled with generic GIS platform opens opportunities for us to answer spatial questions that never been explored before.

## The most relevant SDGs related to the presentation and theme of this session

1st relevant SDG



**7** AFFORDABLE AND CLEAN ENERGY



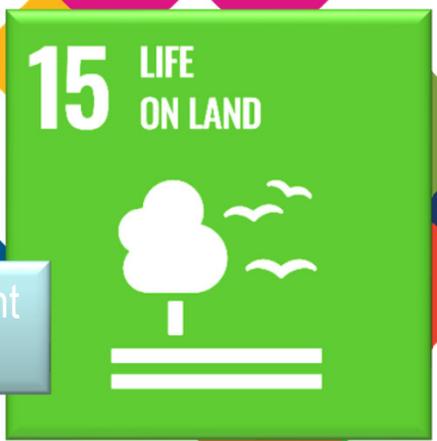
2nd relevant SDG



**13** CLIMATE ACTION



3rd relevant SDG



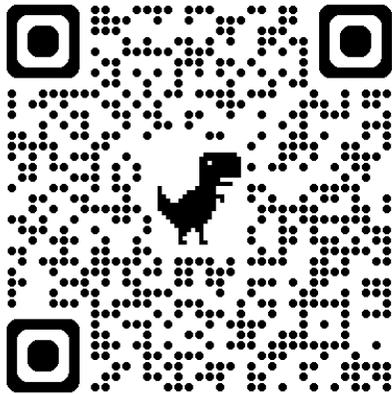
**15** LIFE ON LAND



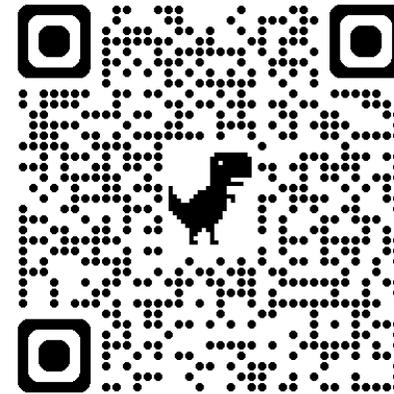
**SUSTAINABLE DEVELOPMENT GOALS**

International Federation of Surveyors supports the Sustainable Development Goals

## Question or feedback?

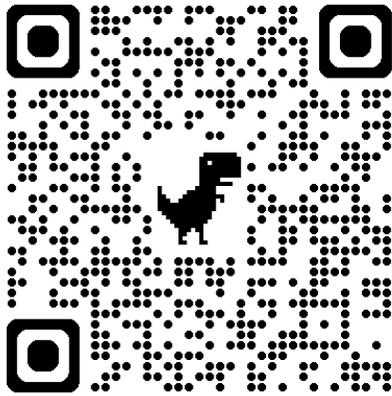


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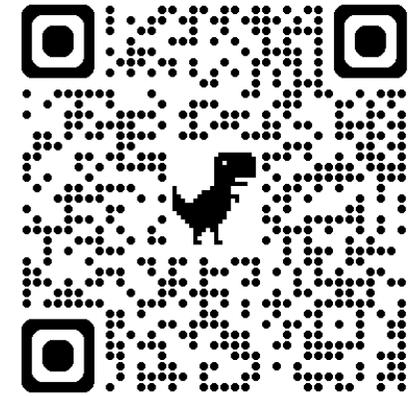


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# Question or feedback?



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STEP 1: SELECT HERE THE THREE MOST RELEVANT SDGs  
STEP 2: COPY THE SDG INTO PREVIOUS SLIDE

<b>1</b> NO POVERTY 	<b>2</b> ZERO HUNGER 	<b>3</b> GOOD HEALTH AND WELL-BEING 	<b>4</b> QUALITY EDUCATION 	<b>5</b> GENDER EQUALITY 	<b>6</b> CLEAN WATER AND SANITATION 	<b>7</b> AFFORDABLE AND CLEAN ENERGY 	<b>8</b> DECENT WORK AND ECONOMIC GROWTH 	<b>9</b> INDUSTRY, INNOVATION AND INFRASTRUCTURE 
<b>10</b> REDUCED INEQUALITIES 	<b>11</b> SUSTAINABLE CITIES AND COMMUNITIES 	<b>12</b> RESPONSIBLE CONSUMPTION AND PRODUCTION 	<b>13</b> CLIMATE ACTION 	<b>14</b> LIFE BELOW WATER 	<b>15</b> LIFE ON LAND 	<b>16</b> PEACE, JUSTICE AND STRONG INSTITUTIONS 	<b>17</b> PARTNERSHIPS FOR THE GOALS 	