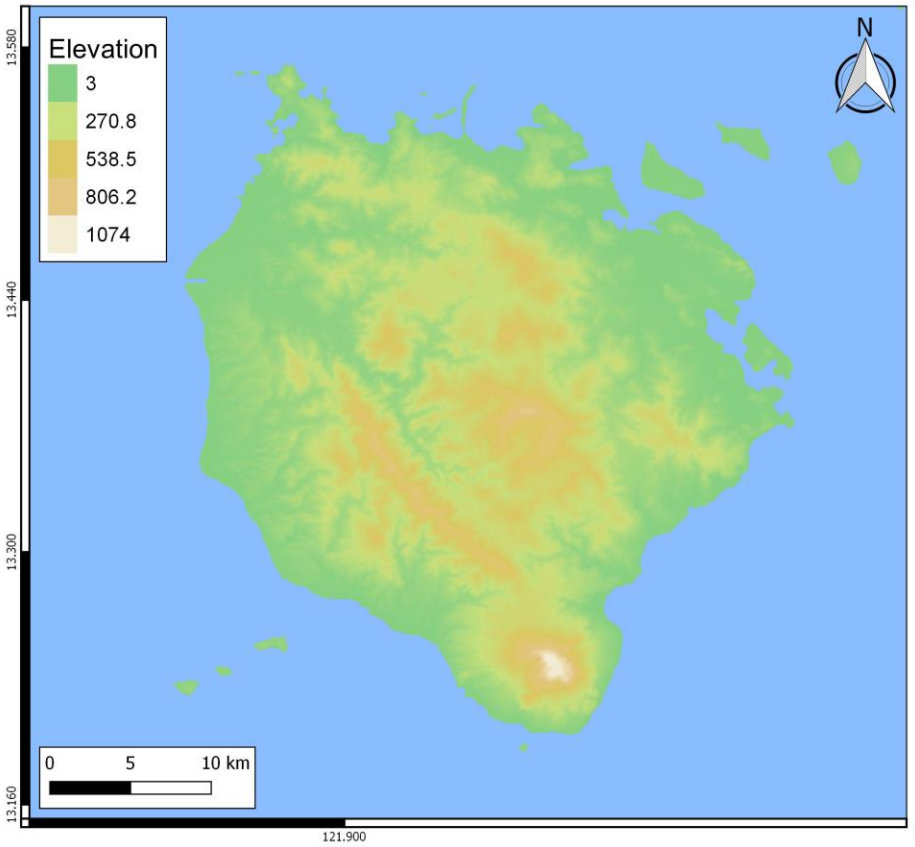
Exploring for groundwater in a parched section of the tropical island of Marinduque, Philippines

I.M.R. Buen, R.S.Z. Uy, E.P. Vargas

TektonGeoMetrix INCORPORATED

Introduction



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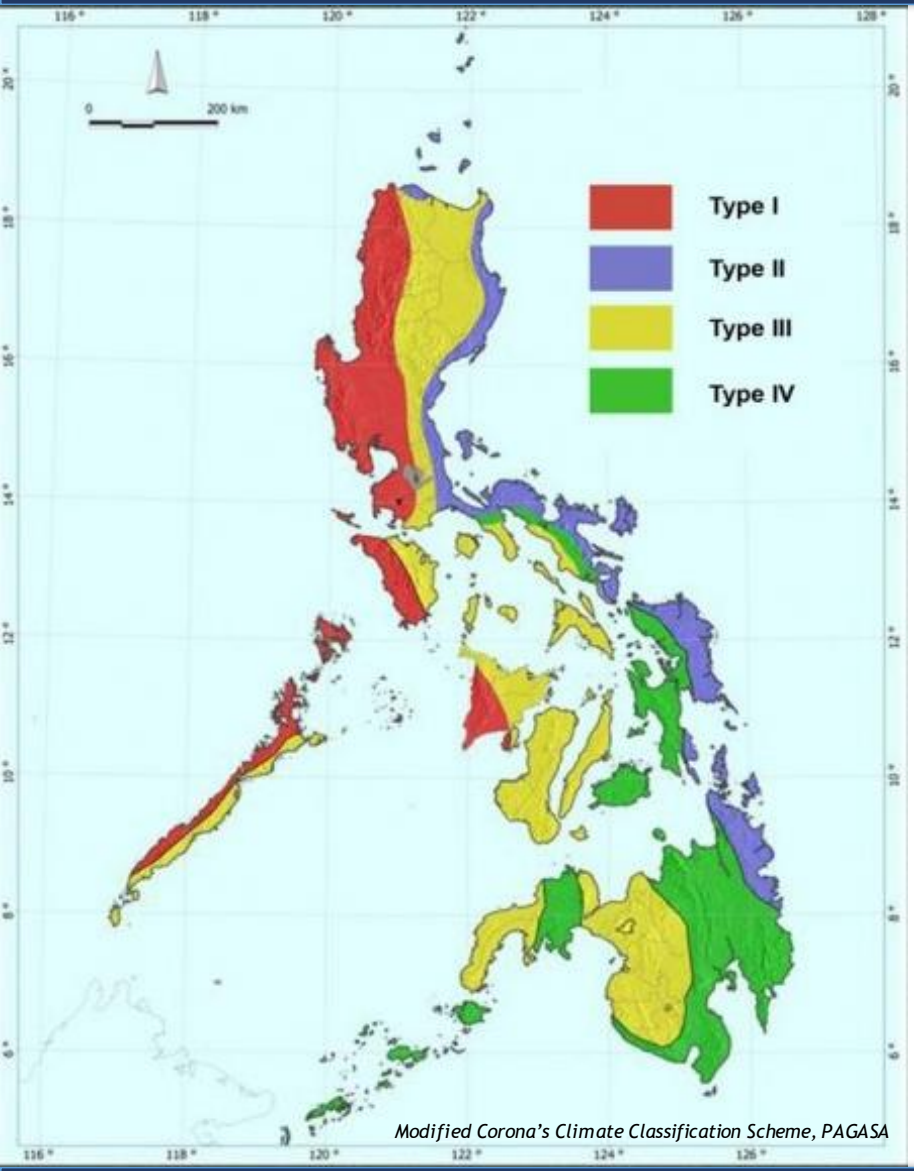
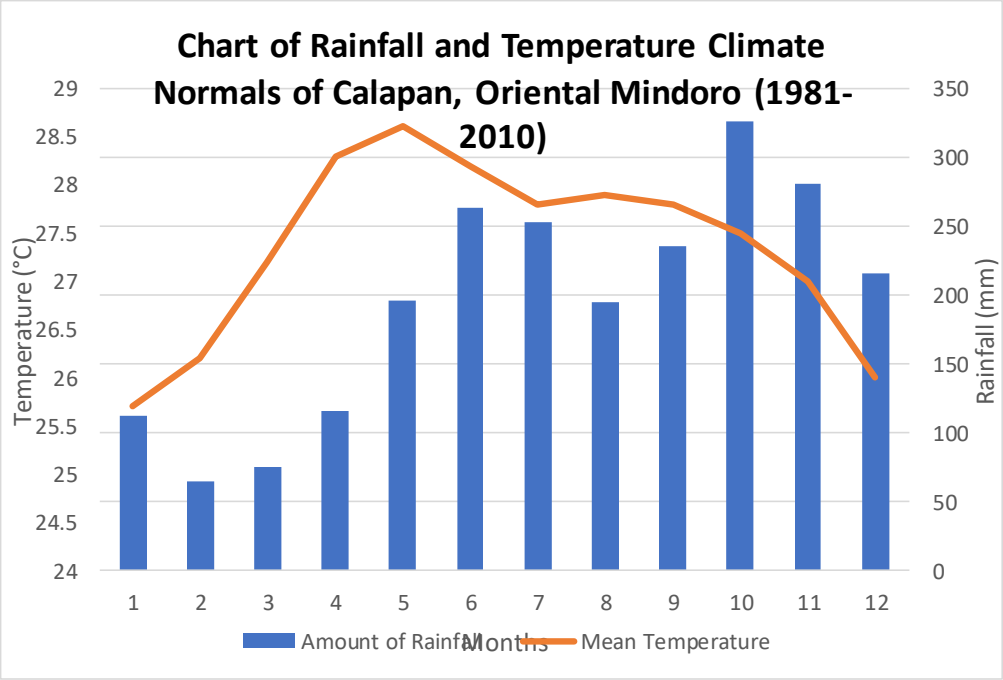


Type III
- relatively dry from November to April

Most amount of rainfall
- October



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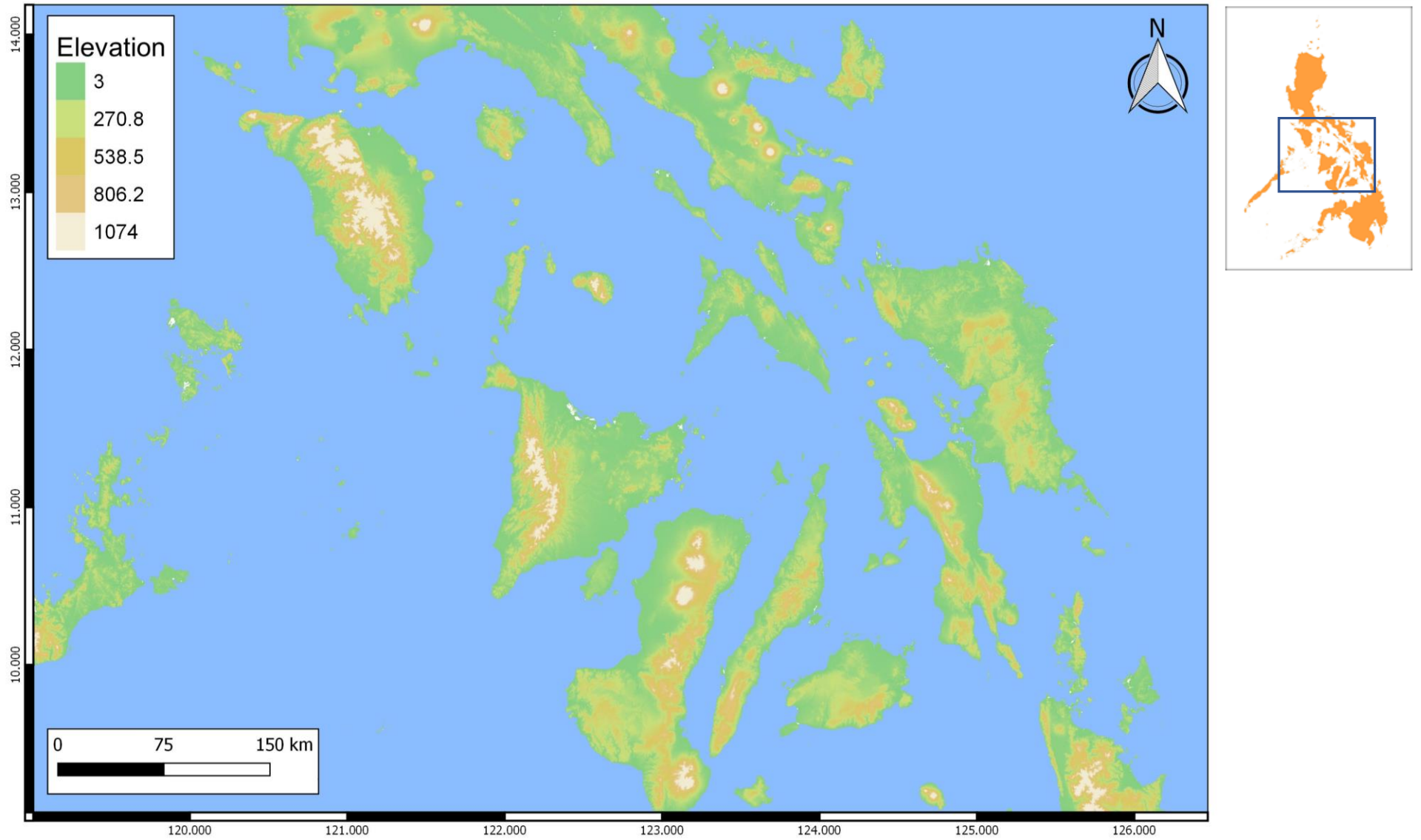

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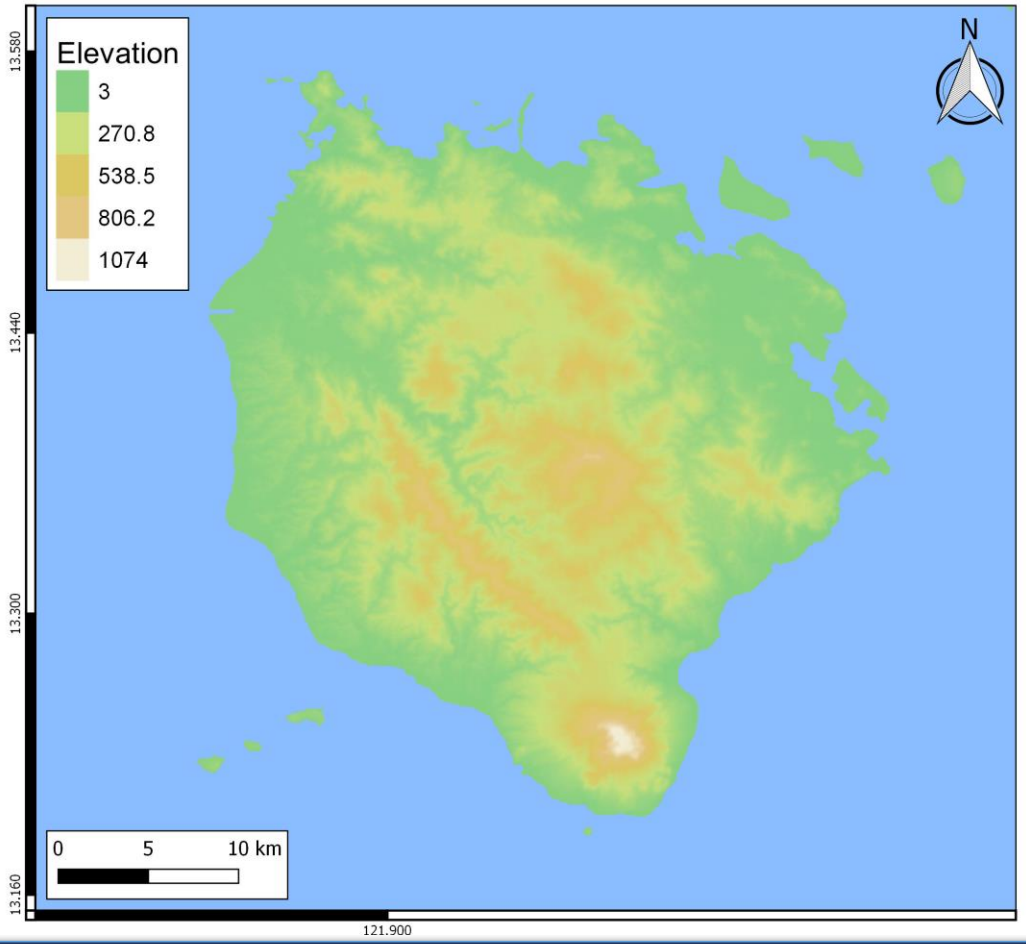
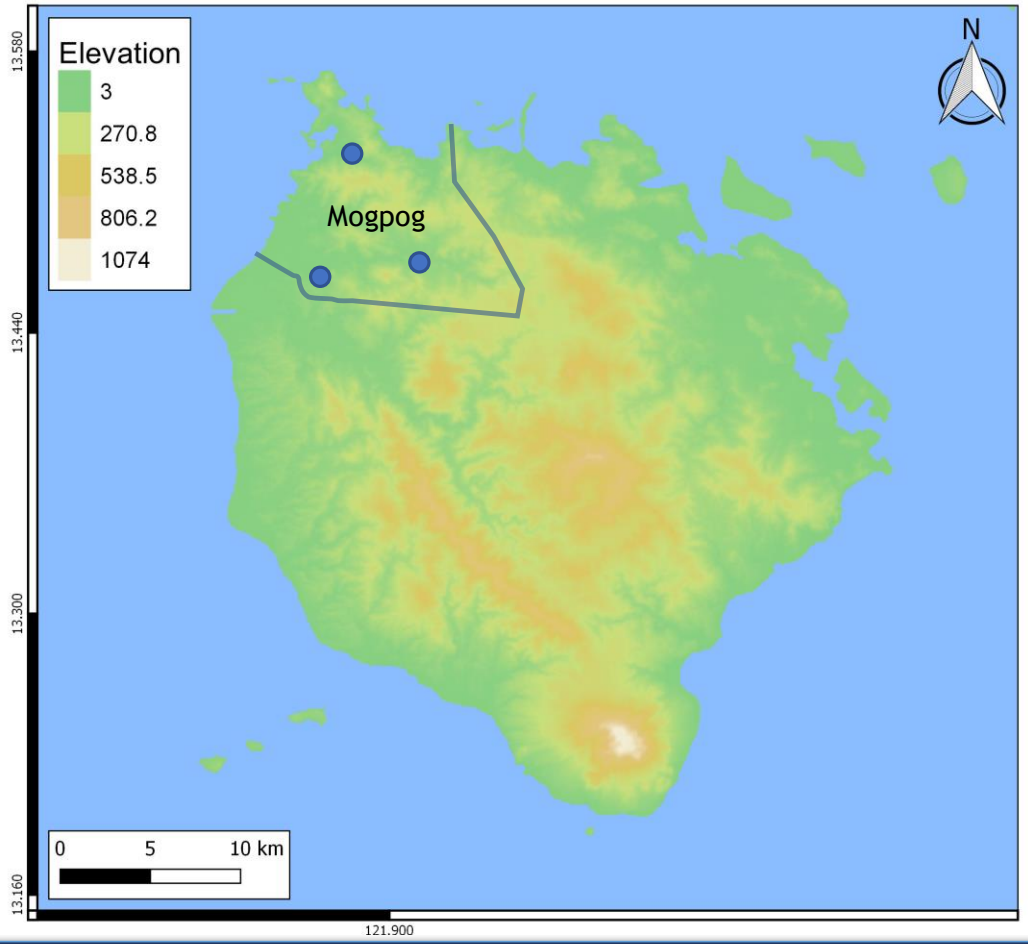


Introduction

Objectives

- Identify sites for drilling of new wells in three barangays (Balanacan, Butansapa, Danao)



Introduction

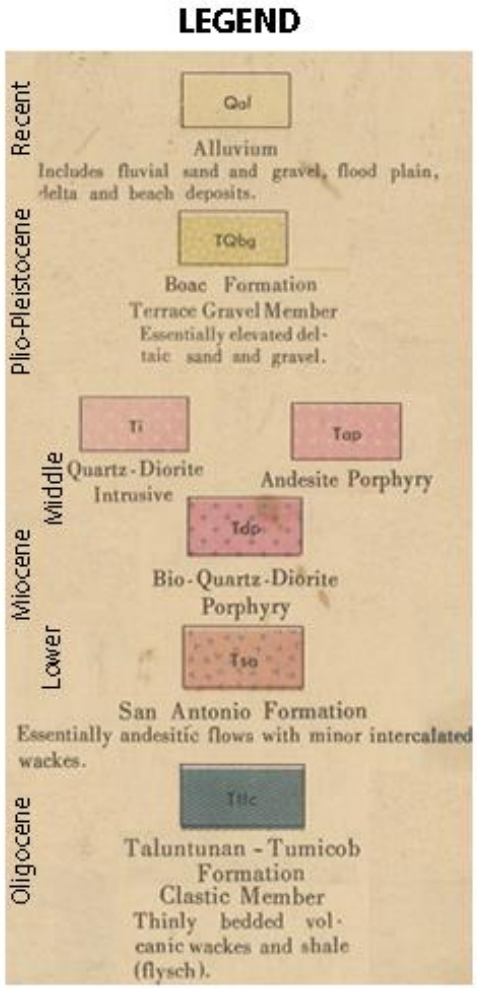
Objectives

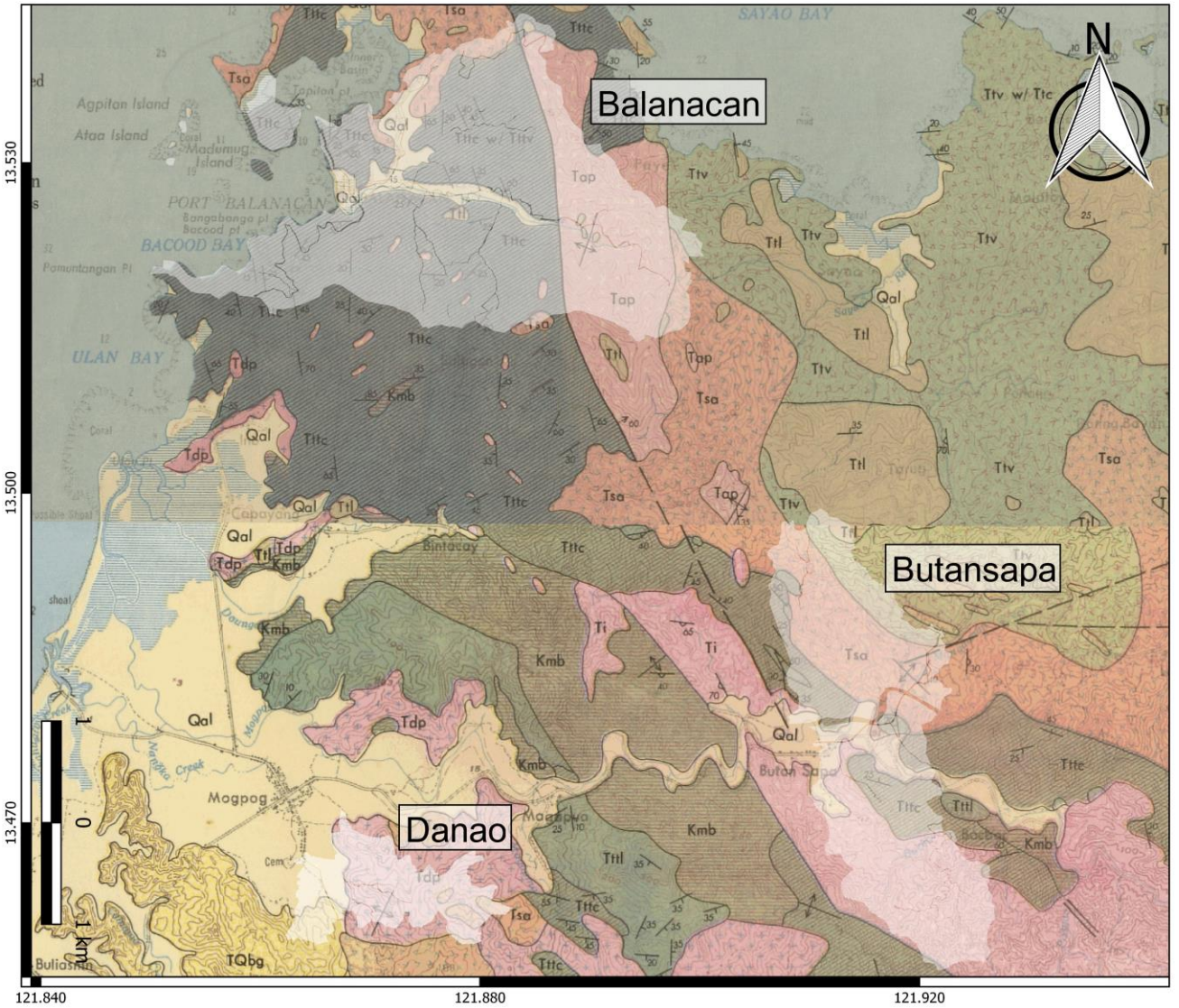
- Identify sites for drilling of new wells in three barangays (Balanacan, Butansapa, Danao)
- Conduct groundwater resource assessment

Methods

- Literature review of existing geological and groundwater availability maps
  - alluvial materials
  - fault lines
  - highly fractured zones
- Actual observation of terrain, geological, and hydrological conditions
- 2D Electrical Resistivity Tomography (ERT) survey
- Water point inventory (springs, creeks, rivers, water wells)

Methods

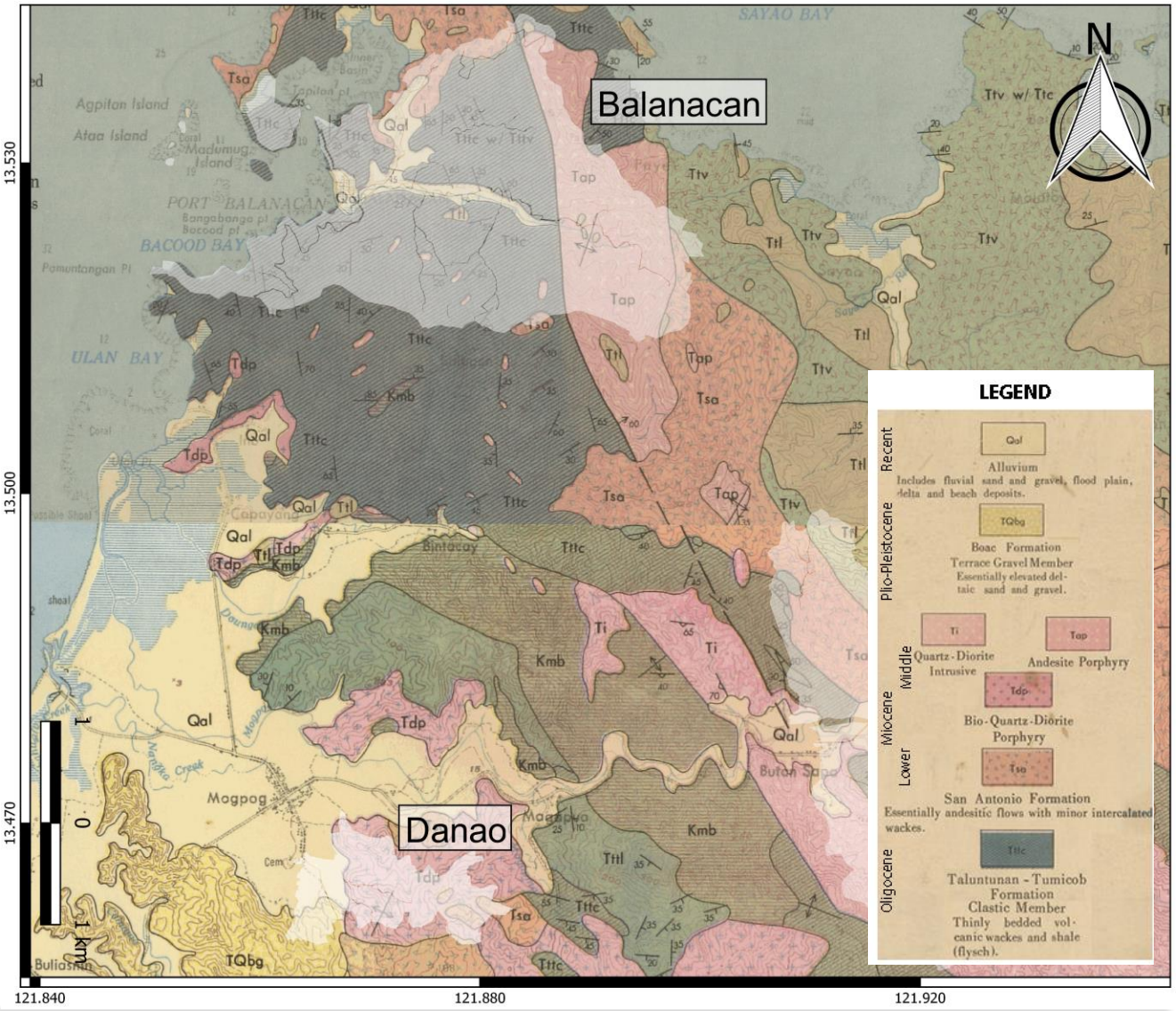

LEGEND
Recent
Qal
Alluvium
Includes fluvial sand and gravel, flood plain, delta and beach deposits.
Plio-Pleistocene
TQbg
Boac Formation
Terrace Gravel Member
Essentially elevated deltaic sand and gravel.
Miocene
Middle
Ti
Quartz-Diorite Intrusive
Tap
Andesite Porphyry
Tdp
Bio-Quartz-Diorite Porphyry
Lower
Tsa
San Antonio Formation
Essentially andesitic flows with minor intercalated wackes.
Oligocene
Tttc
Taluntunan-Tumicob Formation
Clastic Member
Thinly bedded volcanic wackes and shale (flysch).


Balanacan
Butansapa
Danao
N
SAYAO BAY
BACOOD BAY
ULAN BAY
PORT BALANACAN
Agpitan Island
Ataa Island
Madumug Island
Capayang
Bintacay
Mogpog
Buliasnin
Tttc
Tsa
Qal
Ttl
Ttv
Tap
Tpp
Tdp
Kmb
Ti
TQbg
13.530
13.500
13.470
121.840
121.880
121.920
1
0
1 km

Methods

Balanacan

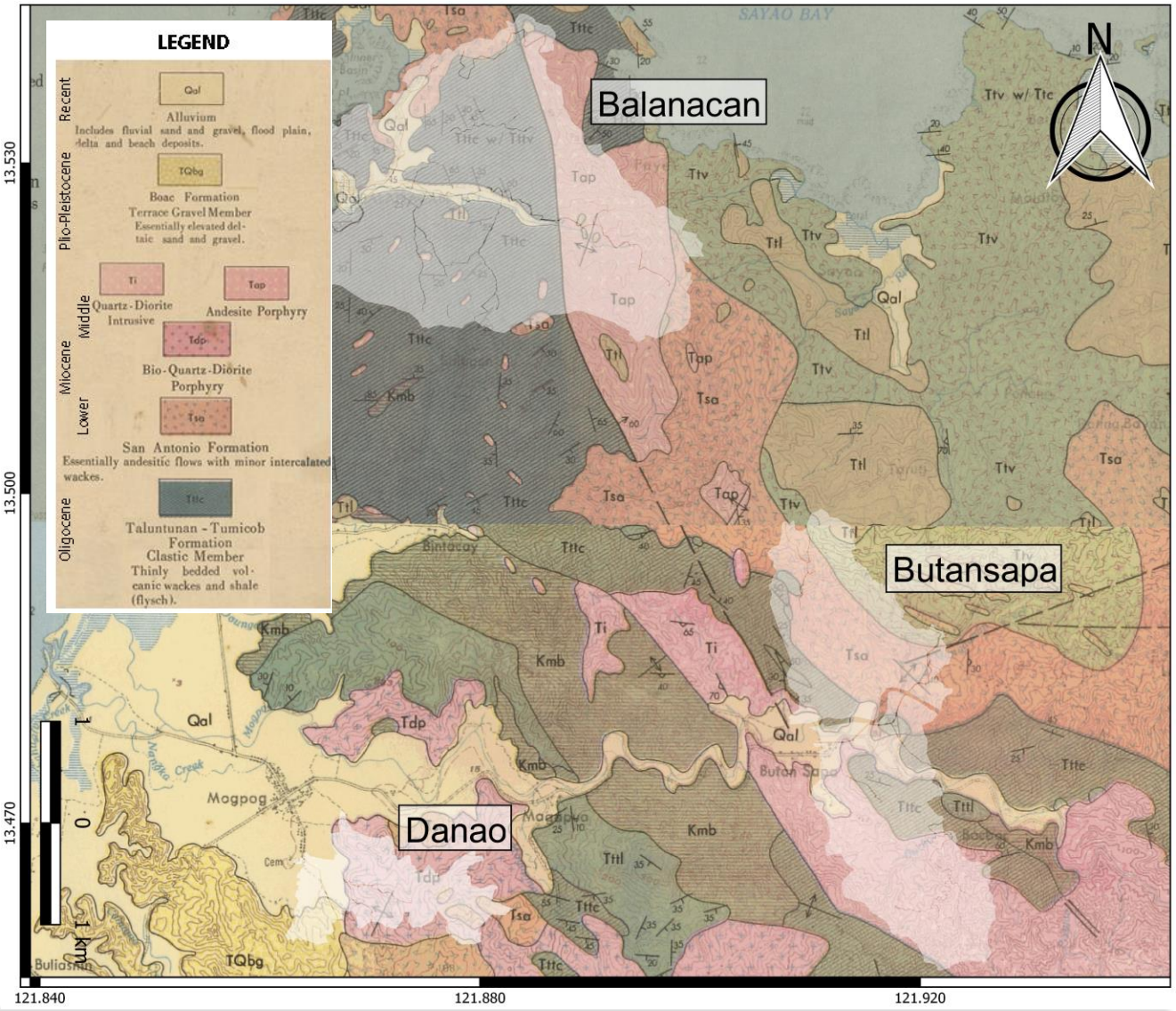
- Taluntunan-Tumicob Formation - turbidites
- Torrijos Formation – andesite porphyry and basalt flow
- Quaternary Alluvium – valley floors



Methods

Butansapa

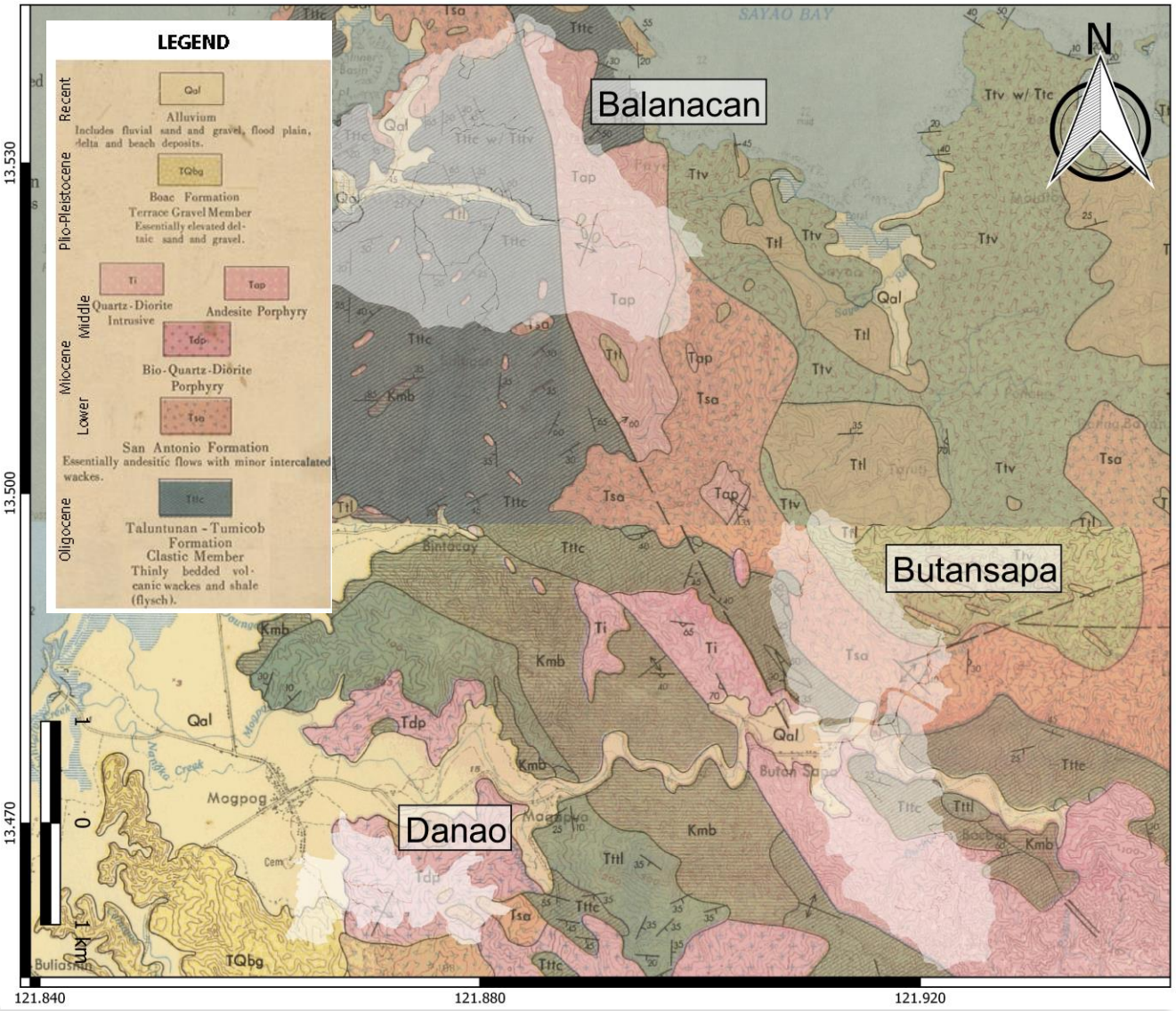
- San Antonio Formation – porphyritic andesite, volcanic breccia, silicified rocks
- Taluntunan-Tumicob Formation - turbidites
- Sta. Cruz Quartz Diorite Intrusion
- Quaternary Alluvium – riverbeds and floodplains



Methods

Danao

- San Antonio Formation - porphyritic andesite, volcanic breccia, silicified rocks
- Torrijos Formation – Bio-Quartz-Diorite porphyry
- Boac Formation – terrace gravel conglomerate
- Quaternary Alluvium



Methods

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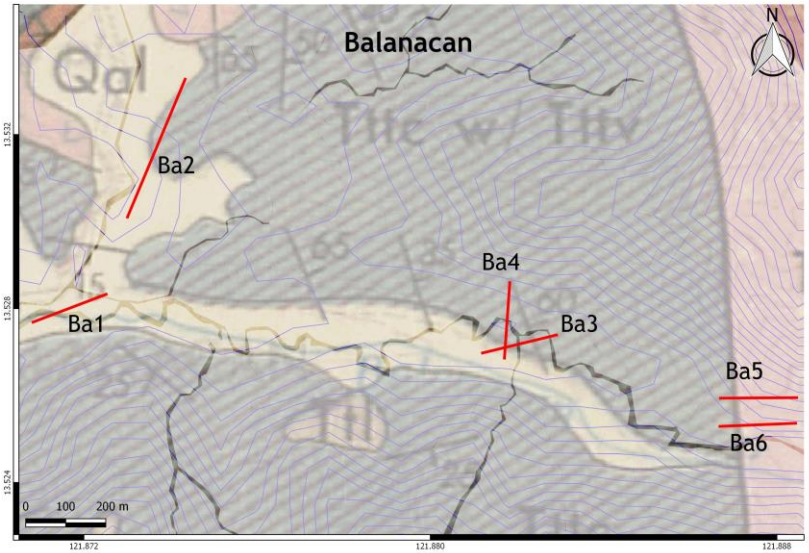
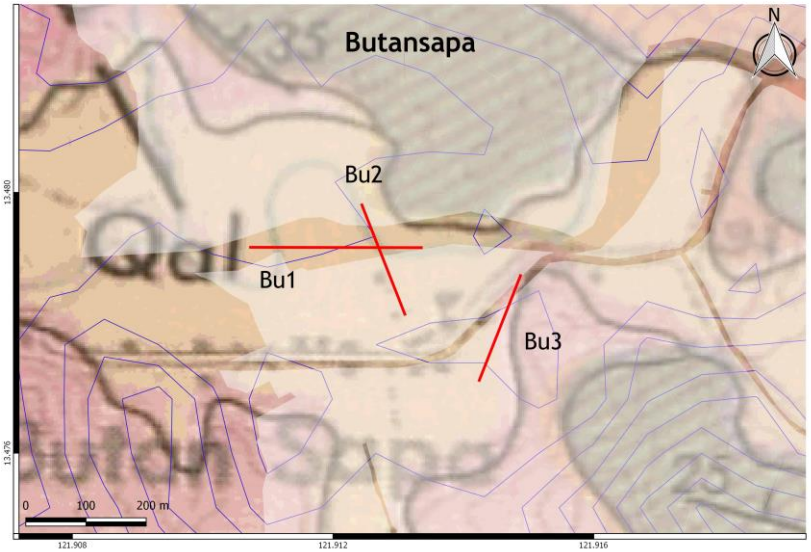
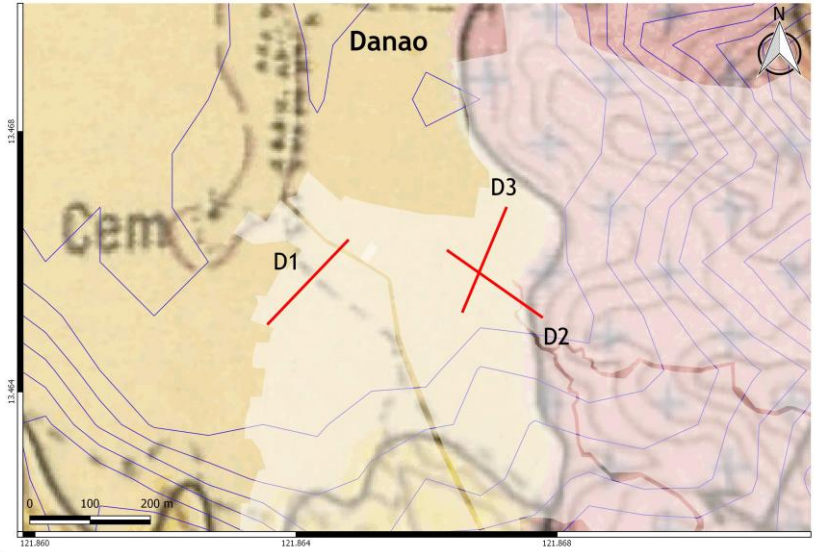
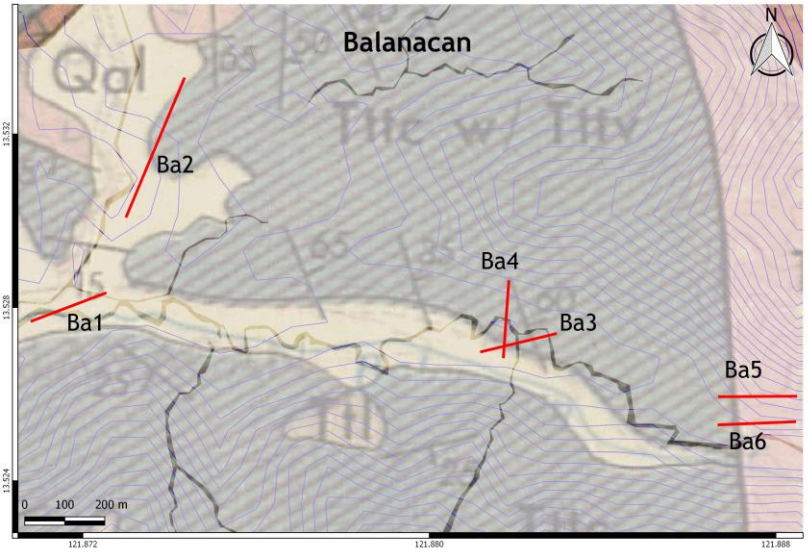
Methods


Balanacan
N
Ba1
Ba2
Ba3
Ba4
Ba5
Ba6
0 100 200 m
121.872
121.880
121.888
13.532
13.528
13.524


Butansapa
N
Bu1
Bu2
Bu3
0 100 200 m
121.908
121.912
121.916
13.480
13.476


Danao
N
D1
D2
D3
0 100 200 m
121.860
121.864
121.868
13.468
13.464

Results


Balanacan
N
Ba1
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0 100 200 m
121.872
121.880
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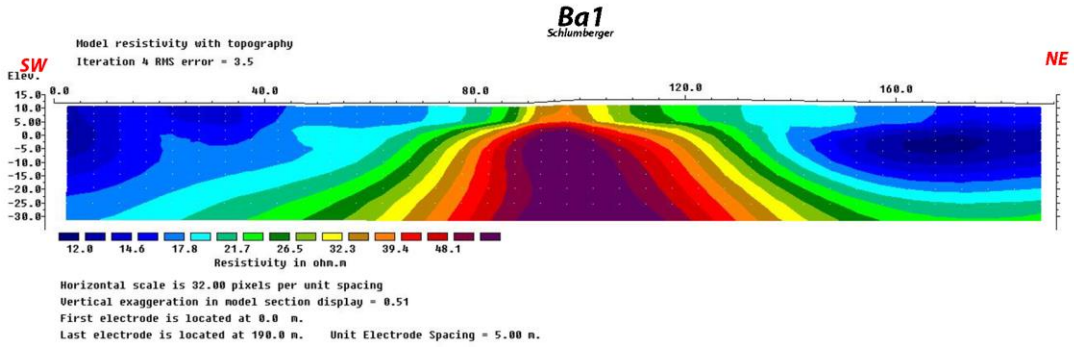
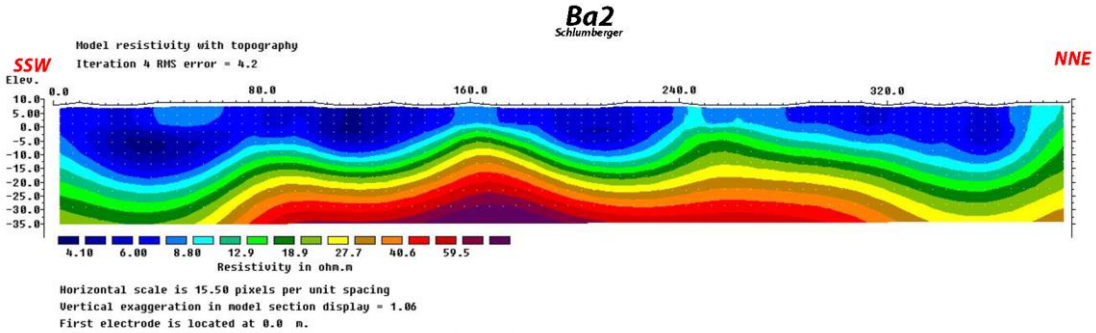
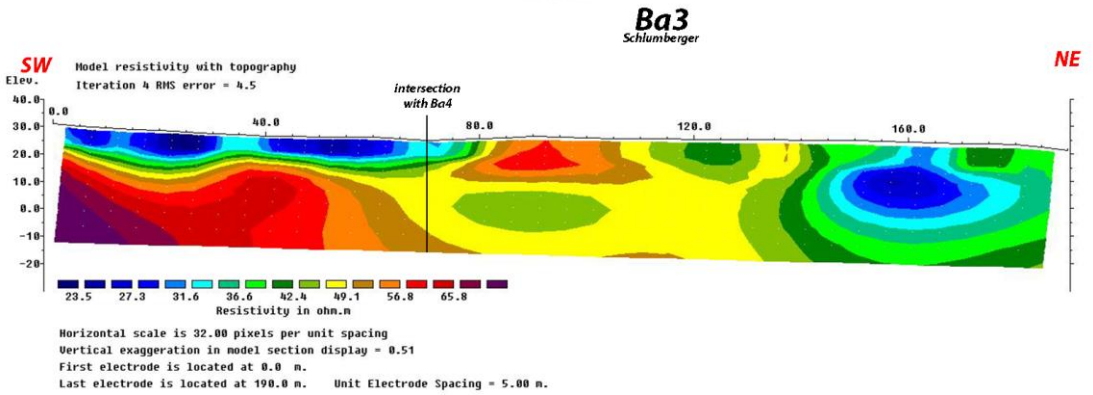
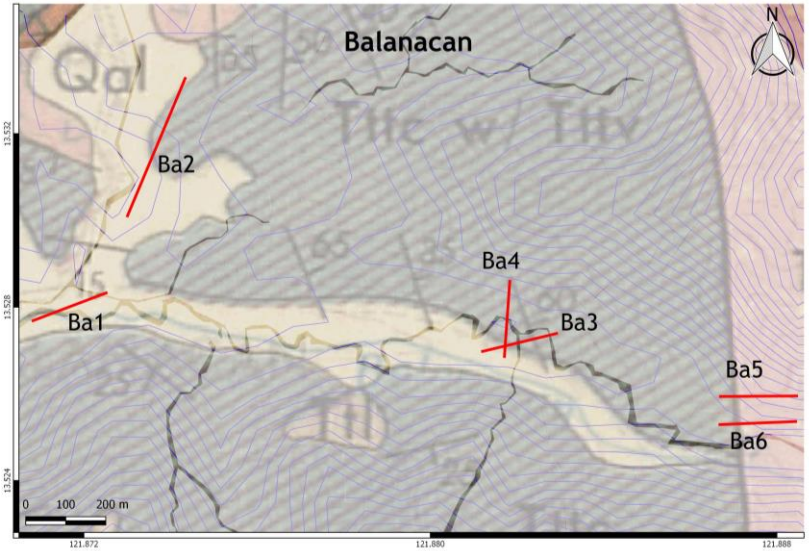
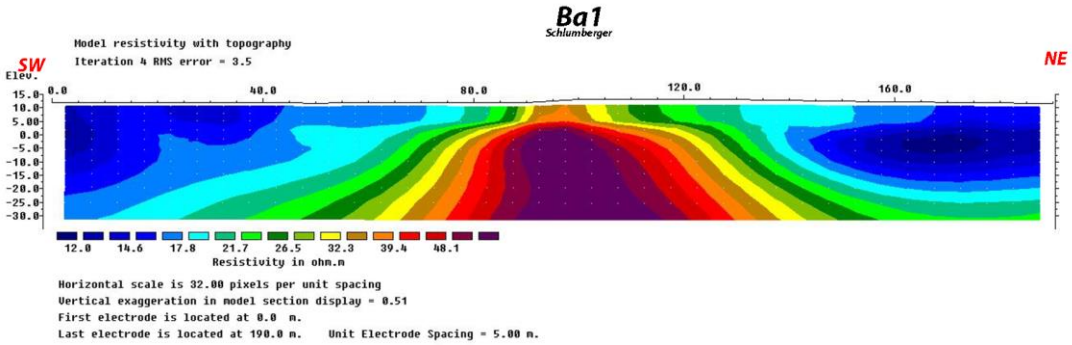

Ba1
Schlumberger
Model resistivity with topography
Iteration 4 RMS error = 3.5
SW
NE
Elev.
0.0 40.0 80.0 120.0 160.0
15.0 10.0 5.00 0.0 -5.0 -10.0 -15.0 -20.0 -25.0 -30.0
12.0 14.6 17.8 21.7 26.5 32.3 39.4 48.1
Resistivity in ohm.m
Horizontal scale is 32.00 pixels per unit spacing
Vertical exaggeration in model section display = 0.51
First electrode is located at 0.0 m.
Last electrode is located at 190.0 m. Unit Electrode Spacing = 5.00 m.

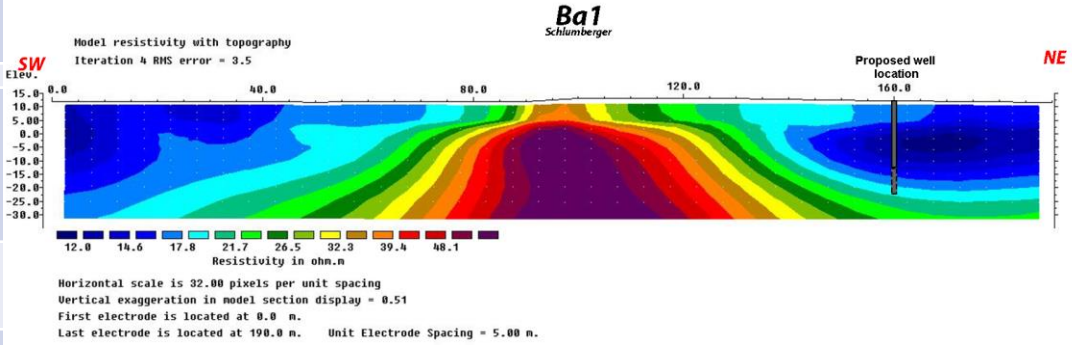

Ba2
Schlumberger
Model resistivity with topography
Iteration 4 RMS error = 4.2
SSW
NNE
Elev.
0.0 80.0 160.0 240.0 320.0
10.0 5.00 0.0 -5.0 -10.0 -15.0 -20.0 -25.0 -30.0 -35.0
4.10 6.00 8.80 12.9 18.9 27.7 40.6 59.5
Resistivity in ohm.m
Horizontal scale is 15.50 pixels per unit spacing
Vertical exaggeration in model section display = 1.06
First electrode is located at 0.0 m.


Ba3
Schlumberger
Model resistivity with topography
Iteration 4 RMS error = 4.5
SW
NE
Elev.
intersection with Ba4
0.0 40.0 80.0 120.0 160.0
40.0 30.0 20.0 10.0 0.0 -10 -20
23.5 27.3 31.6 36.6 42.4 49.1 56.8 65.8
Resistivity in ohm.m
Horizontal scale is 32.00 pixels per unit spacing
Vertical exaggeration in model section display = 0.51
First electrode is located at 0.0 m.
Last electrode is located at 190.0 m. Unit Electrode Spacing = 5.00 m.

Results

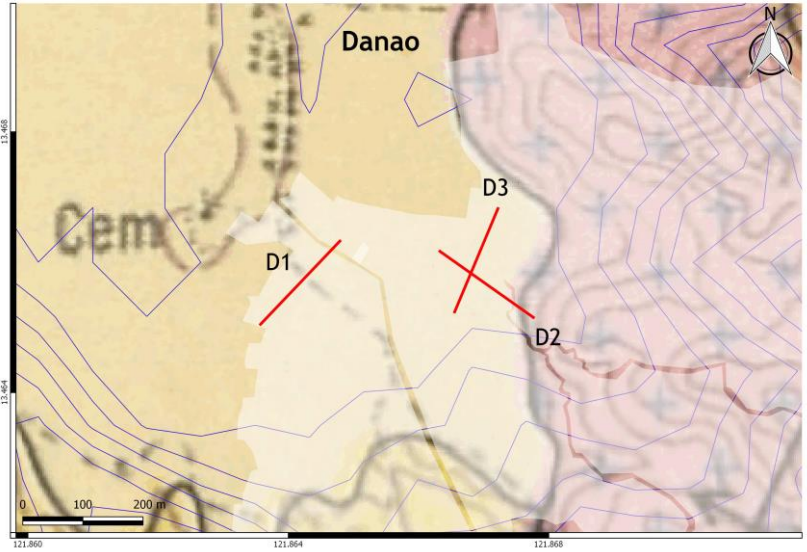


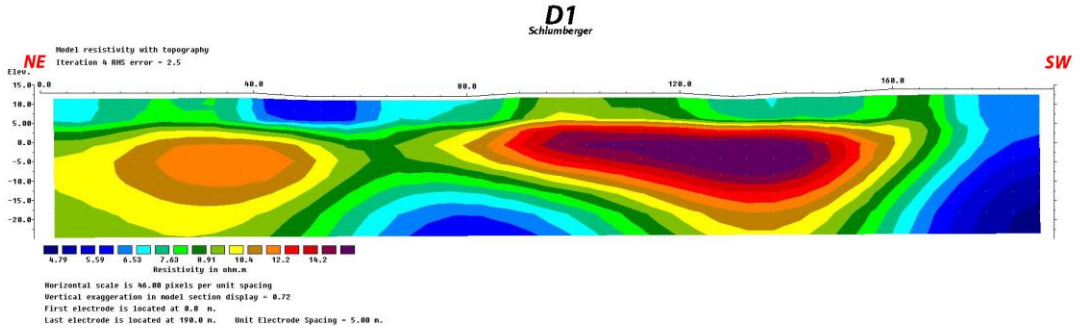


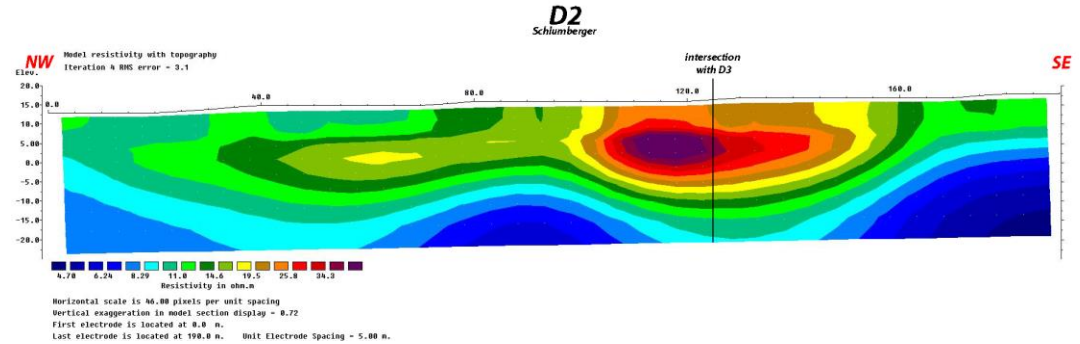


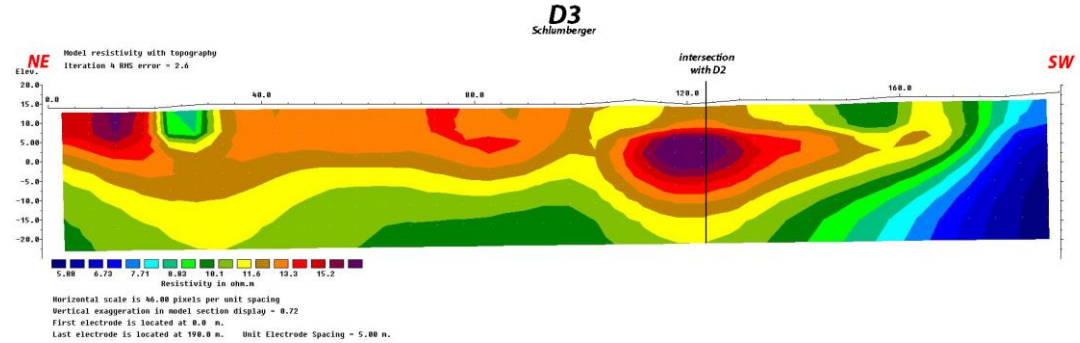
Line	Distance from Origin (m)	Resistivity (ohm-m)	Depth (m)	Geology	Aquifer Type	Remarks
Ba 1	+ 160	12 – 21	25	Alluvium	Water Table	May extend to 35 to tap fractured rocks
Ba 2	-	-	-	-	-	-
Ba 3	+ 20 and +160	27	10 and 30	Alluvium	Water table	May extend to 25 to 30m for first well and 40m for the second well to tap fractured rocks
Ba 4	+ 150	27	30	Alluvium	Water table	May extend to 40m to tap fractured rocks
Ba 5	+ 140	13	10	Alluvium	Water table	May extend to 20m to tap fractured rocks
Ba 6	+ 130	20	40	Alluvium	Water table	May extend to 50m to tap fractured rocks

Results

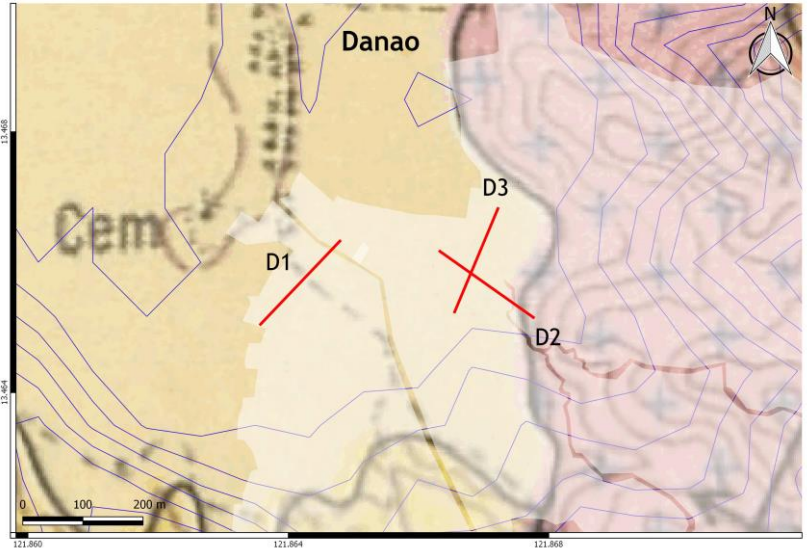

Danao
N
D1
D2
D3
0
100
200 m
121.860
121.864
121.868

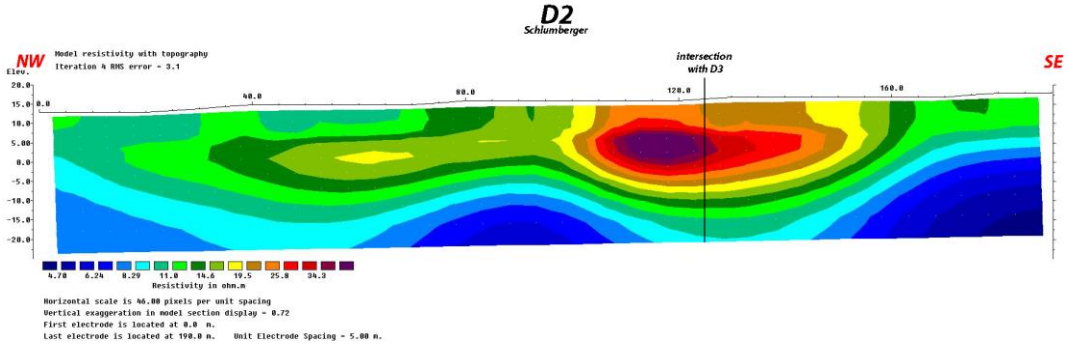

D1
Schlumberger
NE
SW
Model resistivity with topography
Iteration 4 RMS error = 2.5
Resistivity in ohm.m
Horizontal scale is 46.00 pixels per unit spacing
Vertical exaggeration in model section display = 0.72
First electrode is located at 0.0 m.
Last electrode is located at 190.0 m.
Unit Electrode Spacing = 5.00 m.

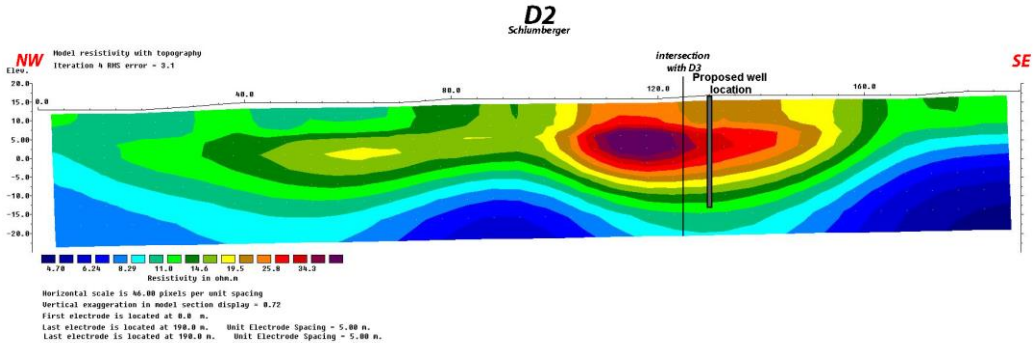

D2
Schlumberger
NW
SE
intersection with D3
Model resistivity with topography
Iteration 4 RMS error = 3.1
Resistivity in ohm.m
Horizontal scale is 46.00 pixels per unit spacing
Vertical exaggeration in model section display = 0.72
First electrode is located at 0.0 m.
Last electrode is located at 190.0 m.
Unit Electrode Spacing = 5.00 m.


D3
Schlumberger
NE
SW
intersection with D2
Model resistivity with topography
Iteration 4 RMS error = 2.6
Resistivity in ohm.m
Horizontal scale is 46.00 pixels per unit spacing
Vertical exaggeration in model section display = 0.72
First electrode is located at 0.0 m.
Last electrode is located at 190.0 m.
Unit Electrode Spacing = 5.00 m.

Results

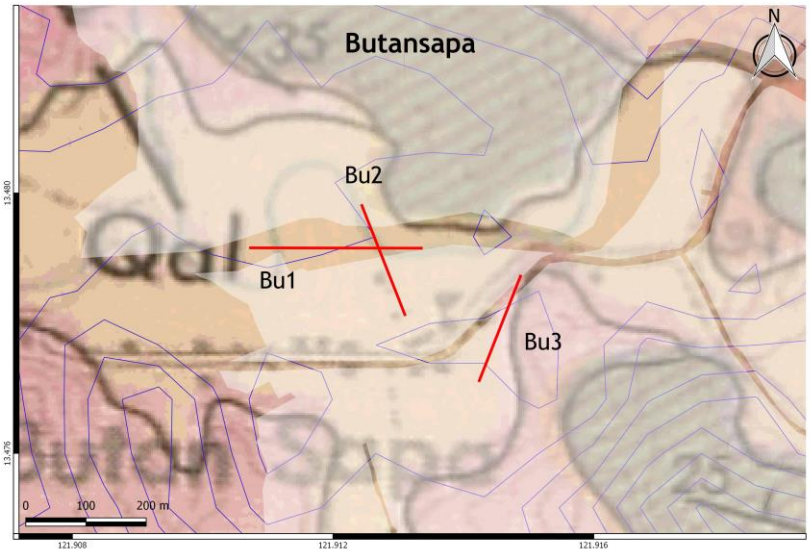


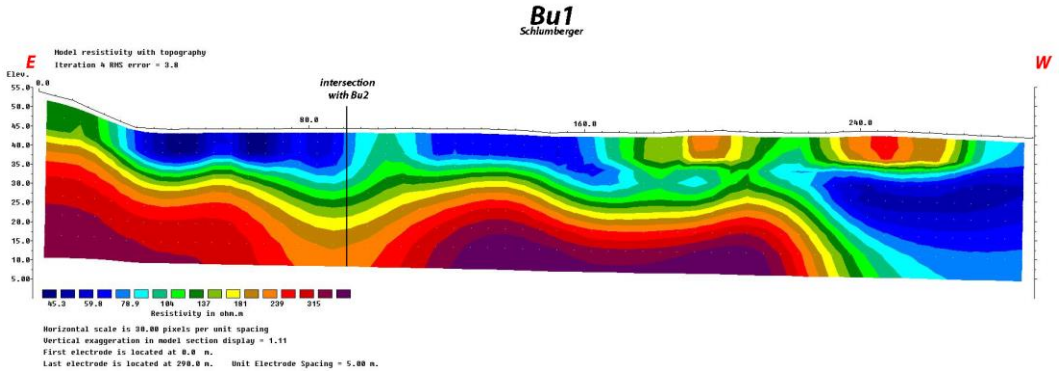


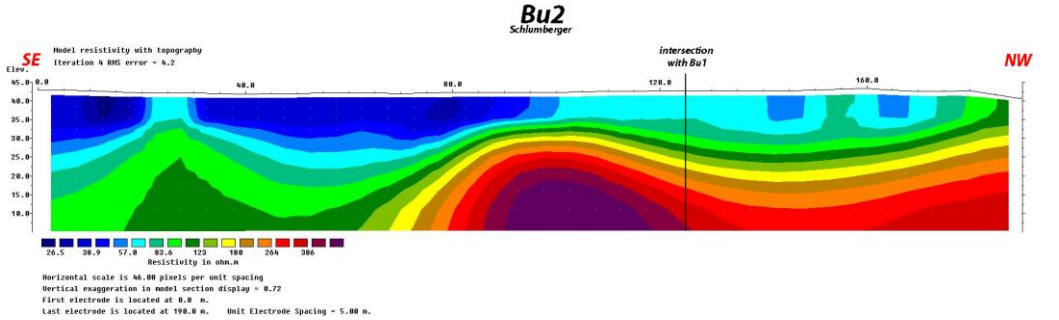


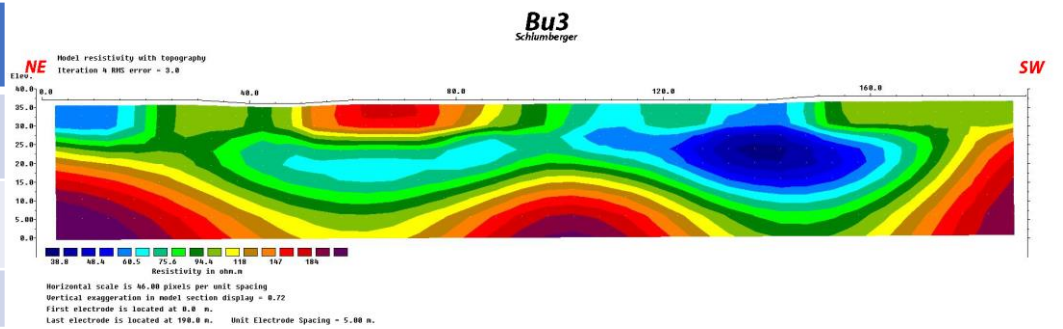
Resistivity Line	Distance from Origin (m)	Resistivity (ohm-m)	Depth (m)	Geology	Aquifer Type	Remarks
D 1	+ 40 and + 140	10-14	35	Alluvium	Water Table/ Semi	With limited recharge at eastern part
D 2	+130	11- 34	30	Alluvium	Water table	
D 3	+ 30 and + 125	10 - 15	35	Alluvium	Water table	

Results









Resistivity Line	Distance from Origin (m)	Resistivity (ohm-m)	Depth (m)	Geology	Aquifer Type	Remarks
Bu 1	+ 240	45-78.9	30-35	Alluvium/Terrace Deposits	Water Table	Gravelly deposits
Bu 2	+50	26-80	15 m	Alluvium/Terrace Deposits	Water Table	Gravelly deposits
Bu 3	+ 140	38-60	25	Alluvium	Water table	

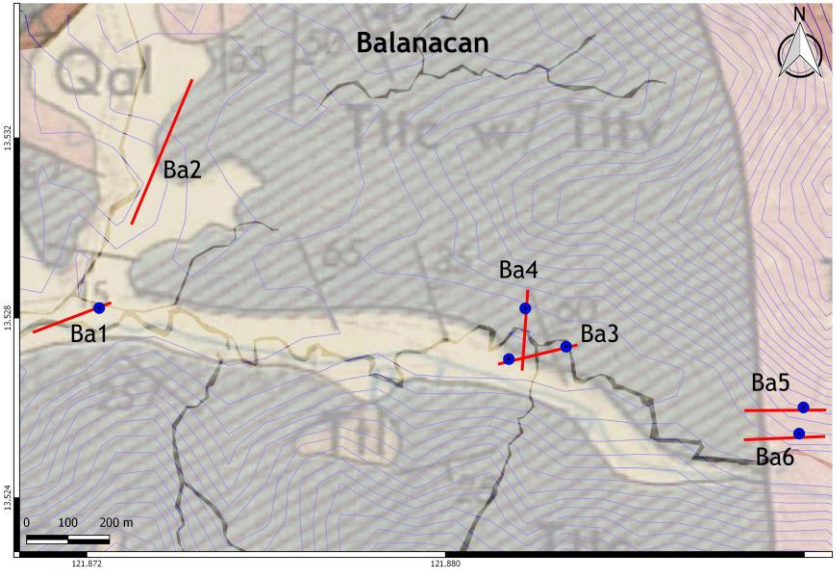
Conclusion

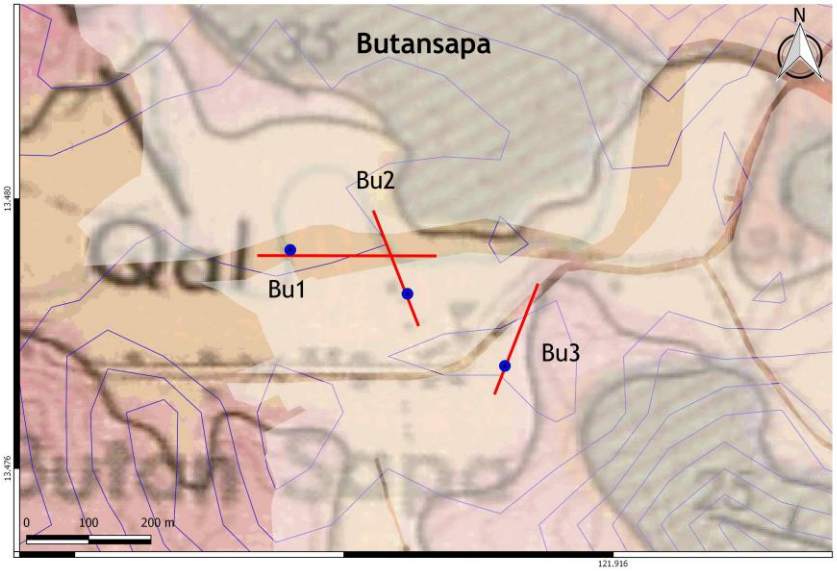
- Taluntunan-Tumicob Formation
  - low groundwater potential
  - clayey and silty composition and highly indurated nature
  - not interconnected pores and spaces

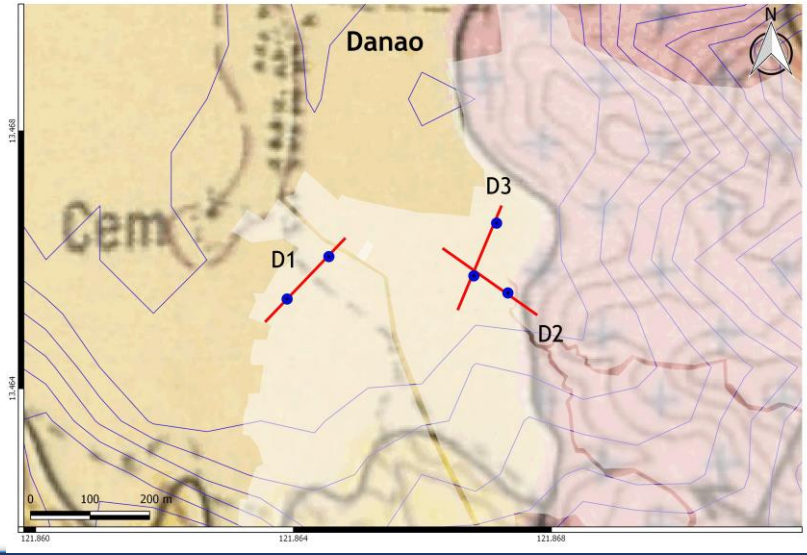
- Torrijos Formation
  - crystalline nature

- Quaternary Alluvium
  - porous and permeable layers
  - very limited extent

Recommendations







Recommendations

- Groundwater in fractured rocks
  - springs or spring boxes
  - limited by the amount of rainfall

- Rehabilitate old springs and water sources


Thank you!