PHYSICAL AND SOCIAL ENVIRONMENTAL ASSESSMENT OF DODANDENIYA AND WATAGODA LANDSLIDES IN MATALE

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INTRODUCTION

- *Matale district has experienced landslides & subsidence during past few decades which could have been accelerated not only due to heavy rainfall but also due to environmental degradation*

- *The study was initiated after ;*
  - *a severe rainfall in December 2014 which set off landslide in Watagoda*
    Rainfall vary from 22 -182 mm (6 days)
  - *subsequent landslide threat issued by NBRO to the Dodandeniya in Matale*

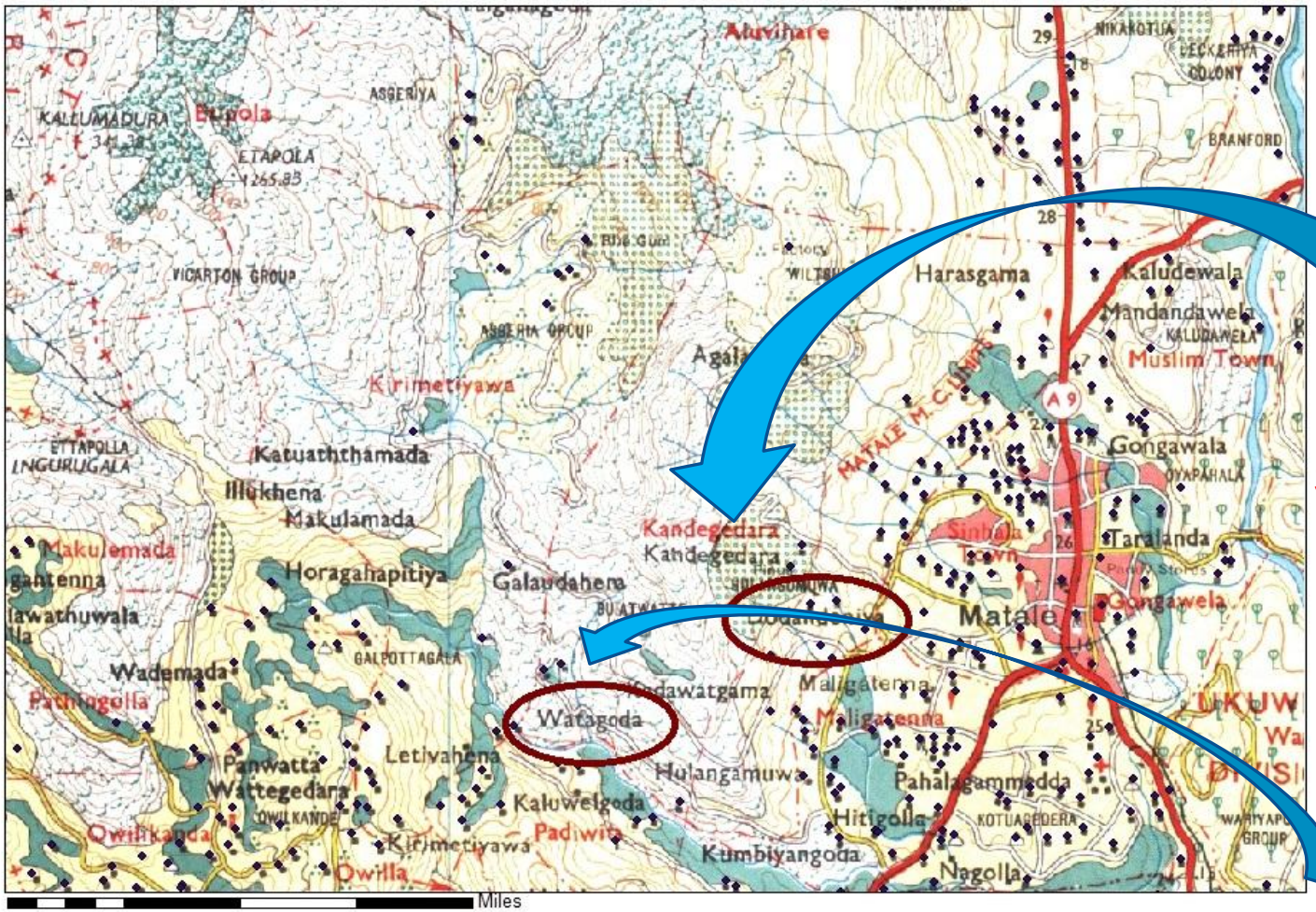
- *Desk studies done by NBRO indicated not only landslide but also land subsidence threat issued to Dodandeniya*

- *Since the population density is high additional social impacts due to landslide and subsidence threat issued to Dodandeniya residents were further investigated*

OBJECTIVES

- *To find the causative factors for the landslide and subsidence threats issued to Dodandeniya residents*
- *To determine whether there are any possibilities for future subsidence and reactivation of landslide*
- *To do preliminary study in Watagoda landslide*

Study Area- Dodandeniya



MC area High Social Impacts (SI)

Watagoda area Low SI

METHODOLOGY

- **Geological Surveys**
  Detailed geological mapping

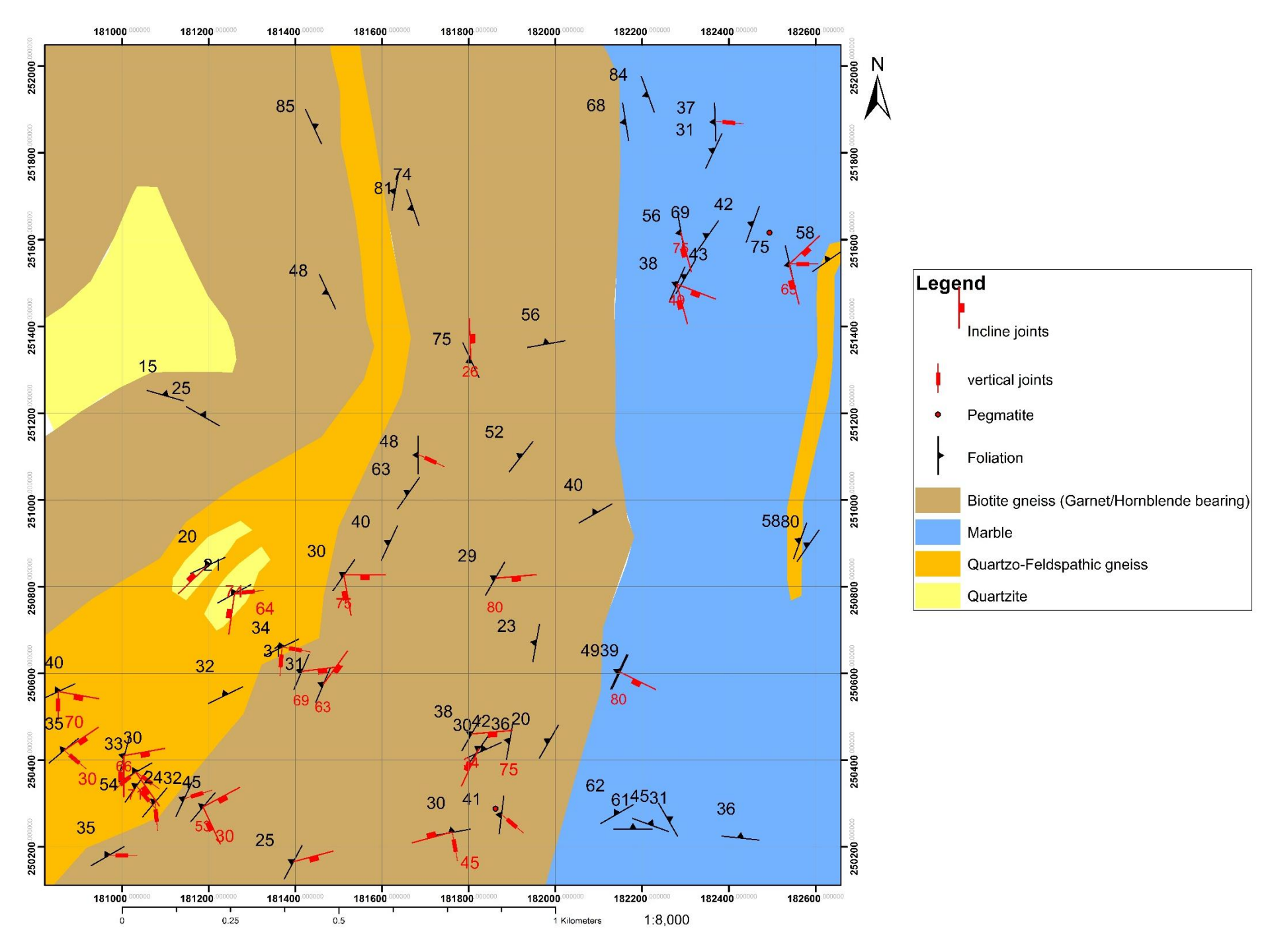
- **Hydrological Surveys**
  Measuring of flow rate

- **Hydro-Chemical Studies**
  Analysis of major cations and major anions

- **Socio Economic Surveys**

RESULTS AND DISCUSSION

Geological Mapping


N
Legend
Incline joints
vertical joints
Pegmatite
Foliation
Biotite gneiss (Garnet/Hornblende bearing)
Marble
Quartzo-Feldspathic gneiss
Quartzite
181000
181200
181400
181600
181800
182000
182200
182400
182600
252000
251800
251600
251400
251200
251000
250800
250600
250400
250200
0
0.25
0.5
1 Kilometers
1:8,000

Geological Mapping

- *Mapping was conducted covering Dodandeniya and Watagoda area*
- *Major rock types encountered*

Dodandeiya

Marble

Biotite gneiss (garnet/ hornblend bearing)

Watagoda

Biotite gneiss (garnet/ hornblend bearing)

Quartzo feldspathic gneiss

Quartzite

Special features observed in marble

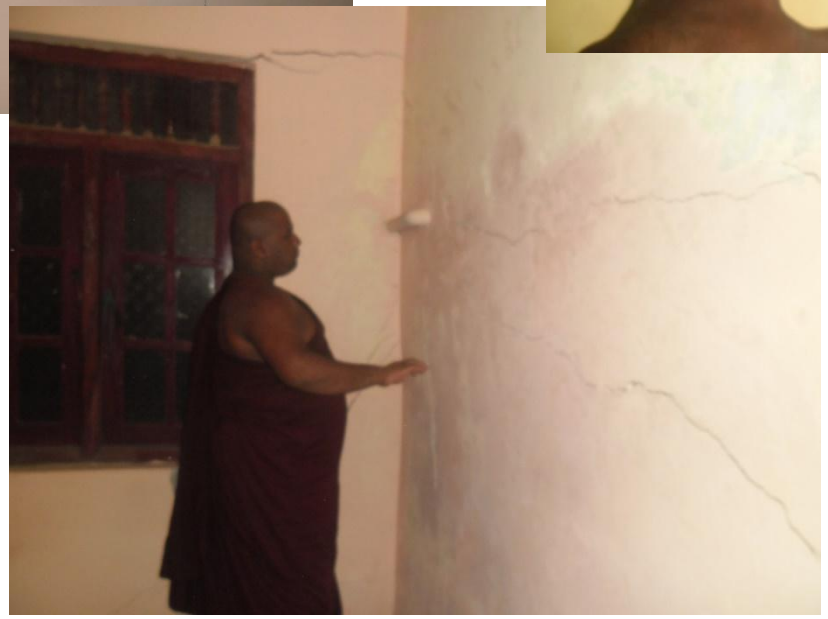
Presence of solution cavities even in the surface exposures

give indication about the possible presence of solution cavities in subsurface

Landslide at Watagoda

CROWN

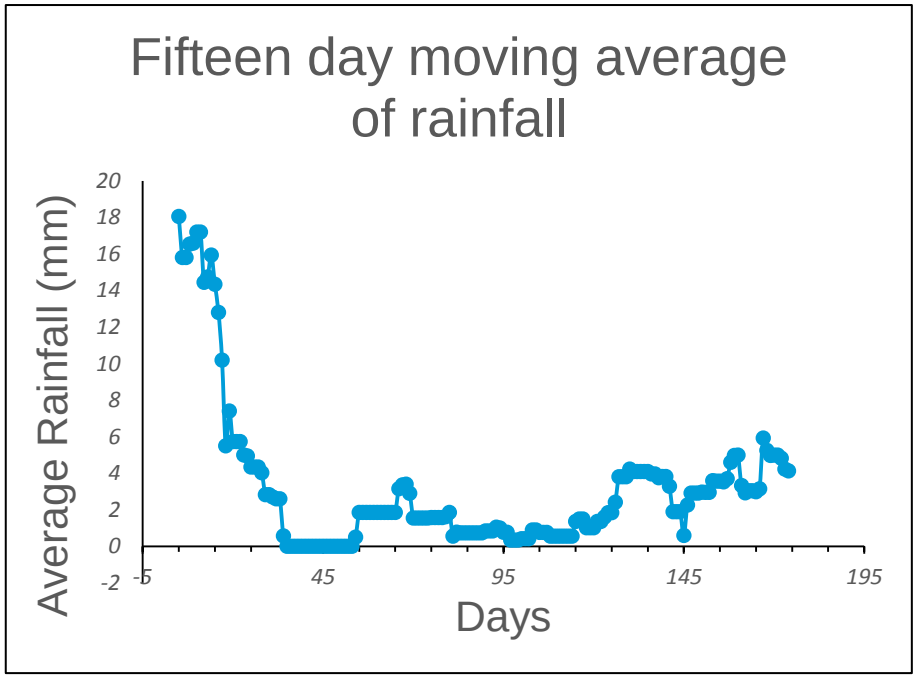
TOE

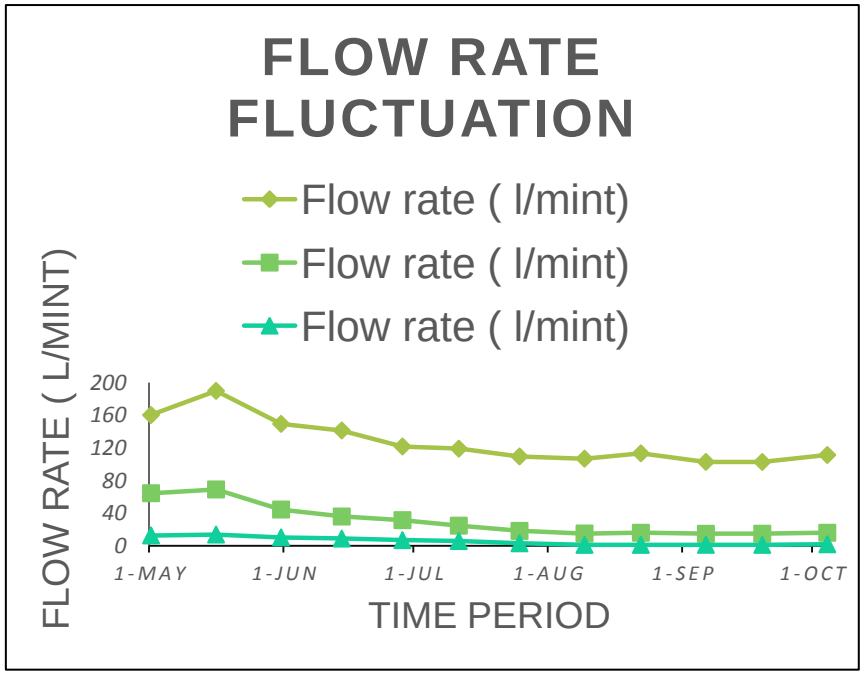


Tensional cracks of houses

FLOW RATE ANALYSIS

Flow rate of three natural springs present in the study area was measured periodically (with 15 day intervals)

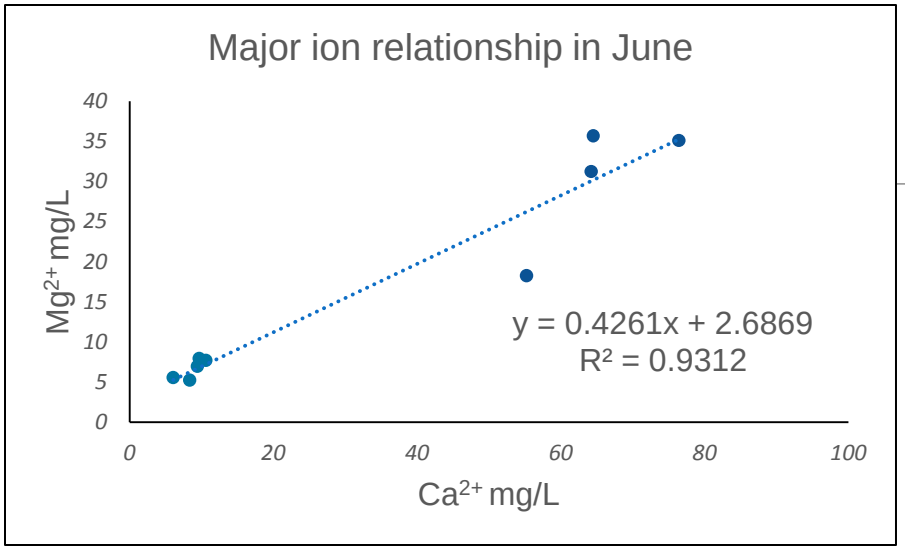


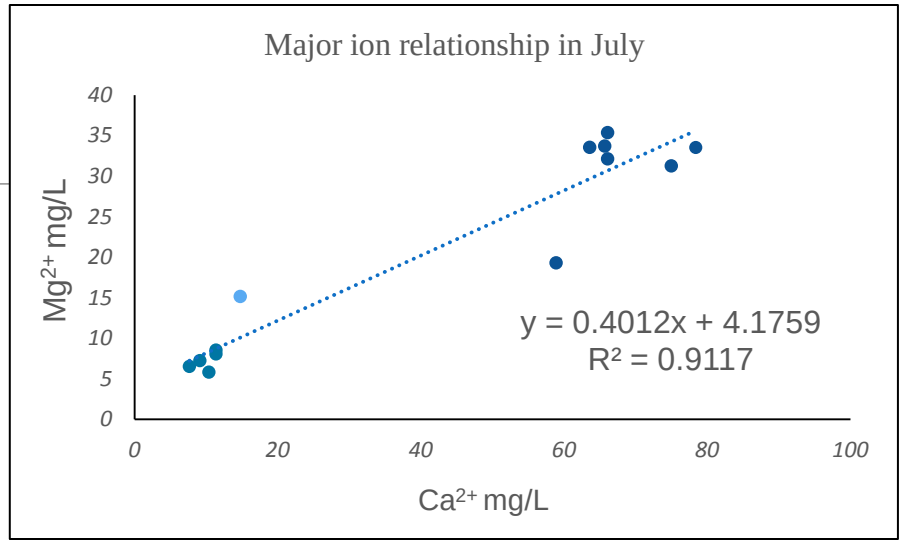


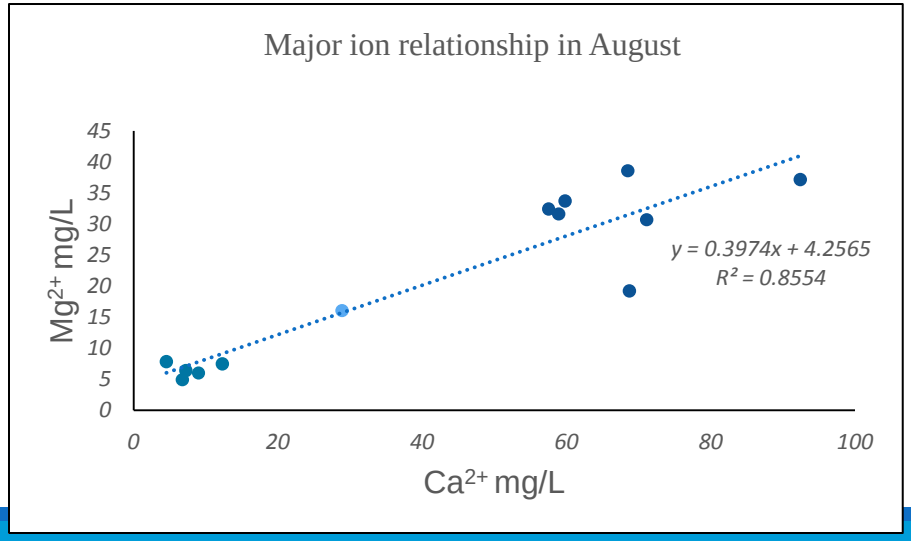
Spring with extreme rate of flow close to the suspected cavity region

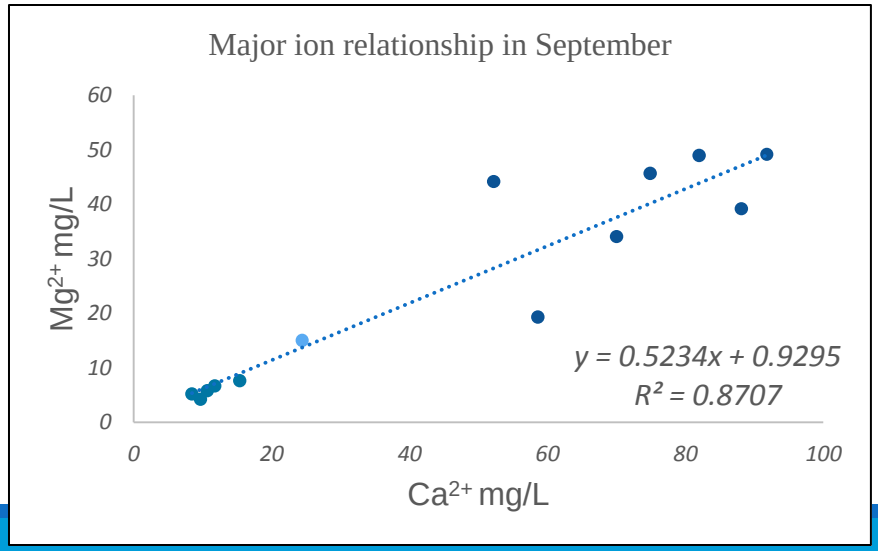
HYDROCHEMICAL ANALYSIS

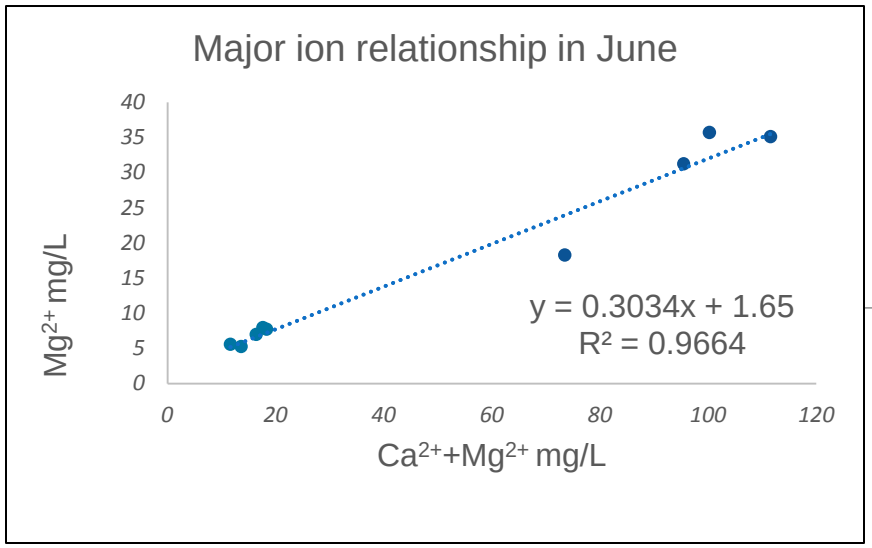
Major ion relationships

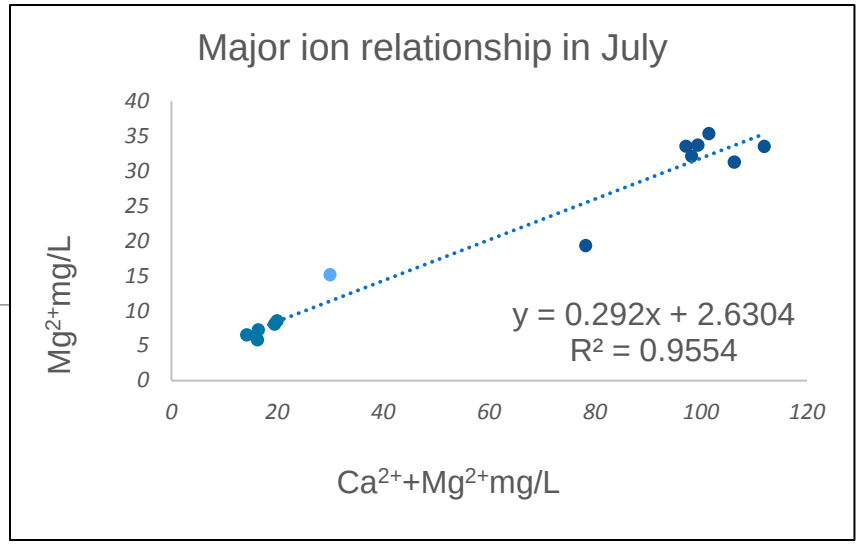


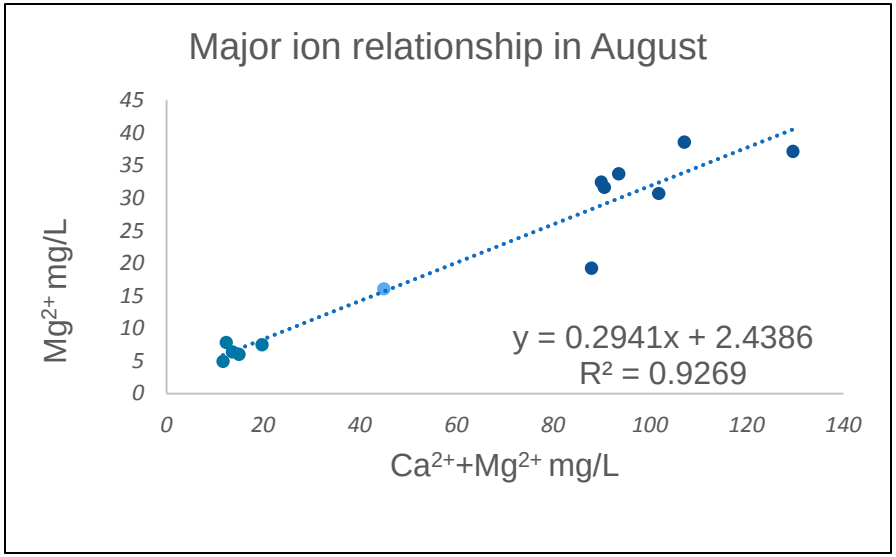


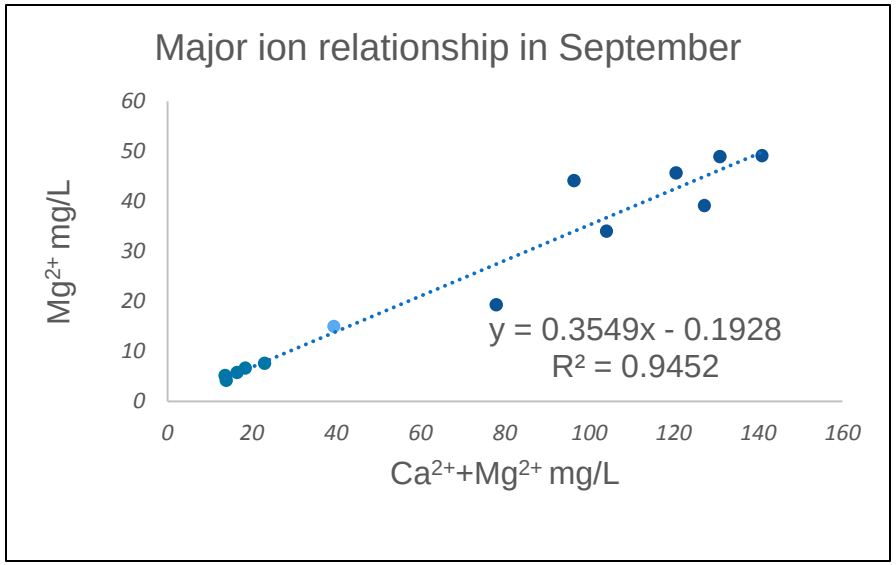


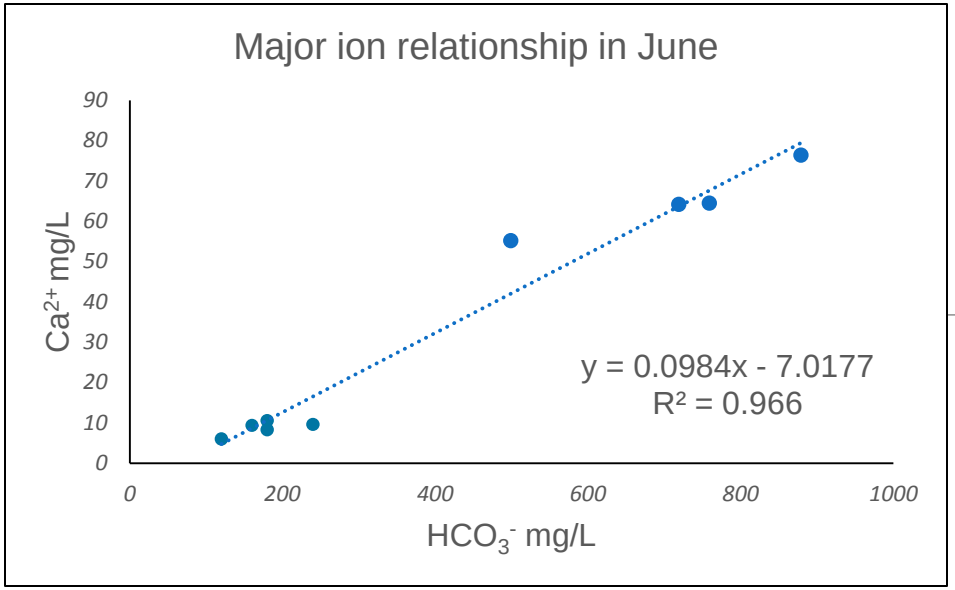


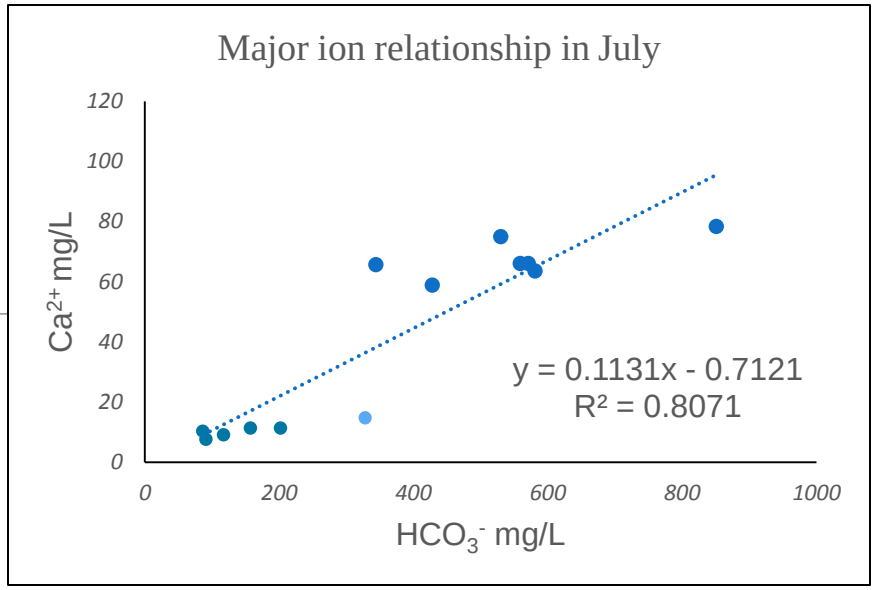

Major ion relationship in June
Mg2+ mg/L
Ca2++Mg2+ mg/L
y = 0.3034x + 1.65
R² = 0.9664
0
5
10
15
20
25
30
35
40
0
20
40
60
80
100
120

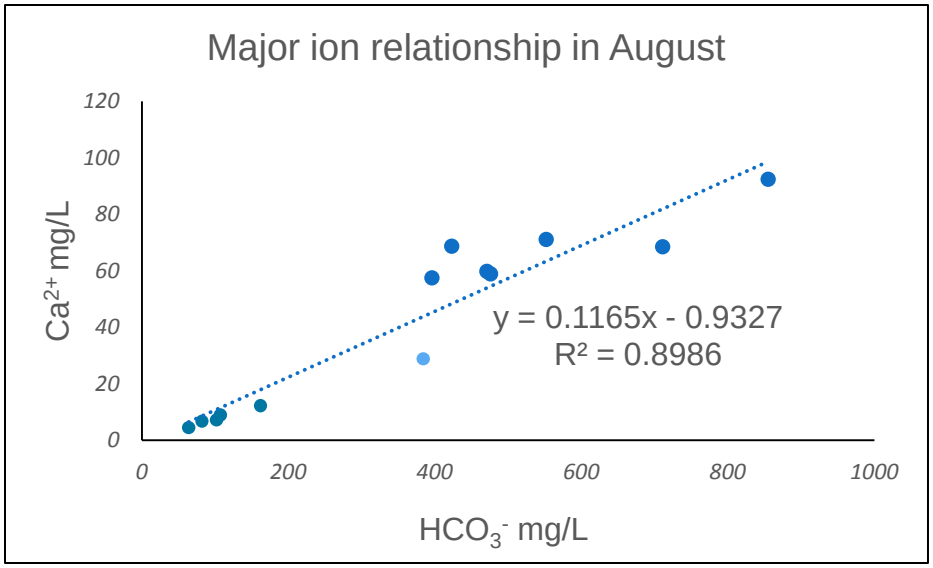

Major ion relationship in July
Mg2+mg/L
Ca2++Mg2+mg/L
y = 0.292x + 2.6304
R² = 0.9554
0
5
10
15
20
25
30
35
40
0
20
40
60
80
100
120

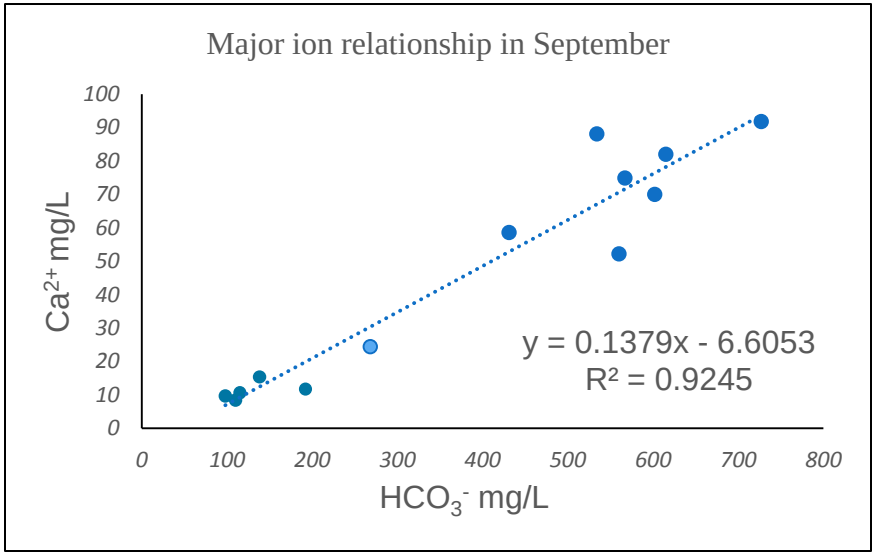

Major ion relationship in August
Mg2+ mg/L
Ca2++Mg2+ mg/L
y = 0.2941x + 2.4386
R² = 0.9269
0
5
10
15
20
25
30
35
40
45
0
20
40
60
80
100
120
140

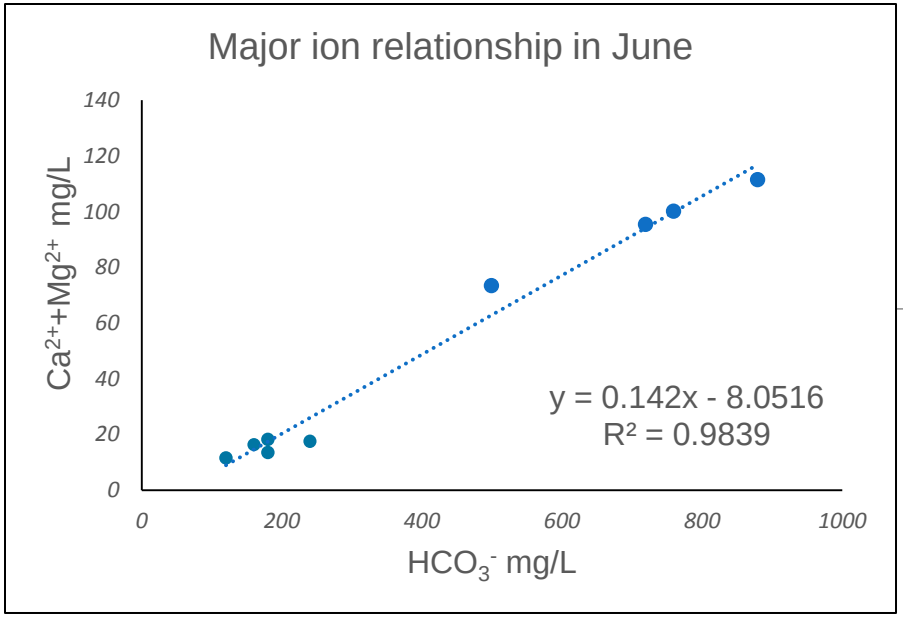

Major ion relationship in September
Mg2+ mg/L
Ca2++Mg2+ mg/L
y = 0.3549x - 0.1928
R² = 0.9452
0
10
20
30
40
50
60
0
20
40
60
80
100
120
140
160

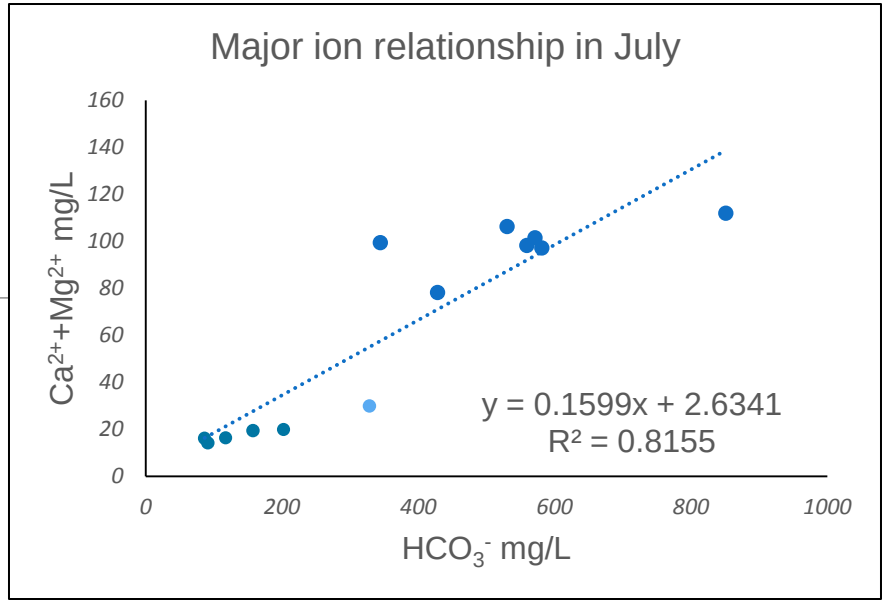

Major ion relationship in June
Ca2+ mg/L
HCO3- mg/L
y = 0.0984x - 7.0177
R² = 0.966
0
10
20
30
40
50
60
70
80
90
0
200
400
600
800
1000

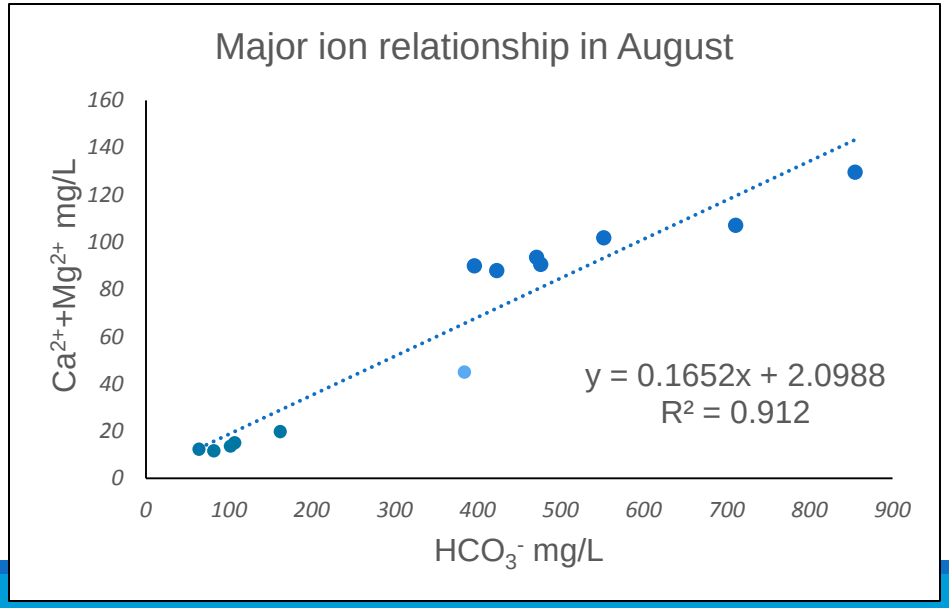

Major ion relationship in July
Ca2+ mg/L
HCO3- mg/L
y = 0.1131x - 0.7121
R² = 0.8071
0
20
40
60
80
100
120
0
200
400
600
800
1000

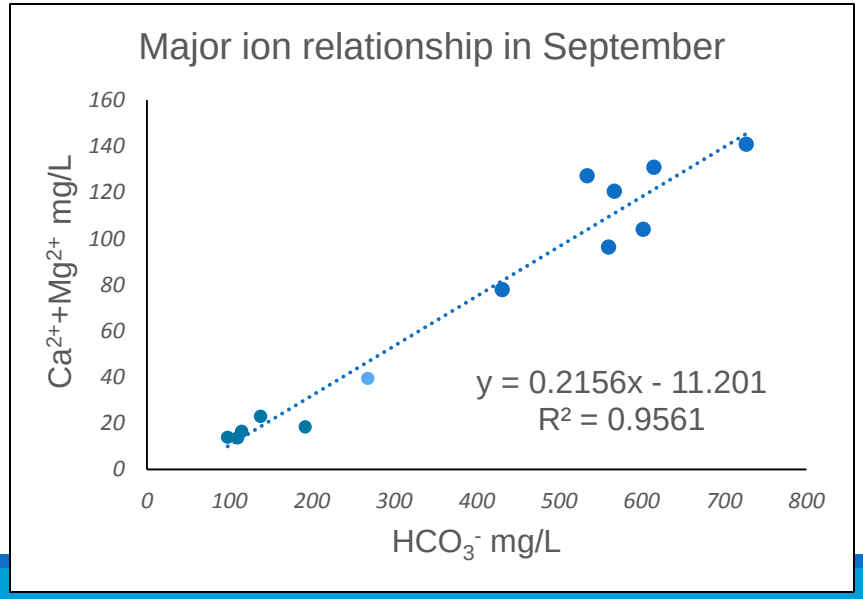

Major ion relationship in August
Ca2+ mg/L
HCO3- mg/L
y = 0.1165x - 0.9327
R² = 0.8986
0
20
40
60
80
100
120
0
200
400
600
800
1000


Major ion relationship in September
Ca2+ mg/L
HCO3- mg/L
y = 0.1379x - 6.6053
R² = 0.9245
0
10
20
30
40
50
60
70
80
90
100
0
100
200
300
400
500
600
700
800


Major ion relationship in June
Ca2++Mg2+ mg/L
HCO3- mg/L
y = 0.142x - 8.0516
R² = 0.9839
0
20
40
60
80
100
120
140
0
200
400
600
800
1000

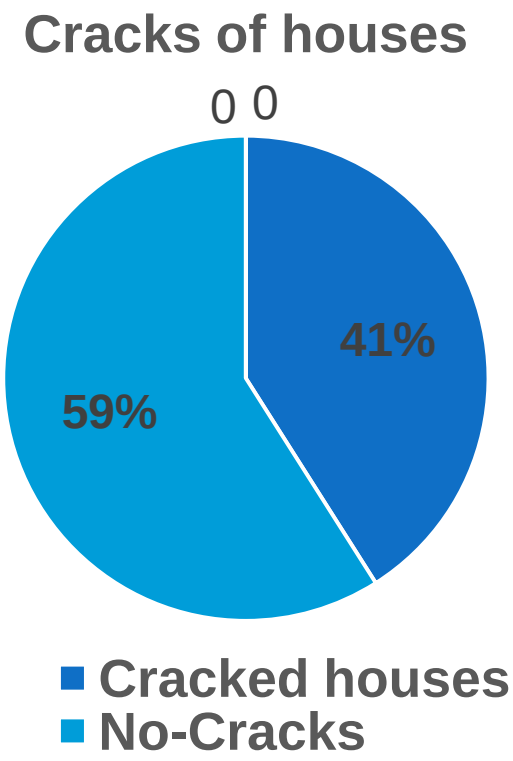

Major ion relationship in July
Ca2++Mg2+ mg/L
HCO3- mg/L
y = 0.1599x + 2.6341
R² = 0.8155
0
20
40
60
80
100
120
140
160
0
200
400
600
800
1000

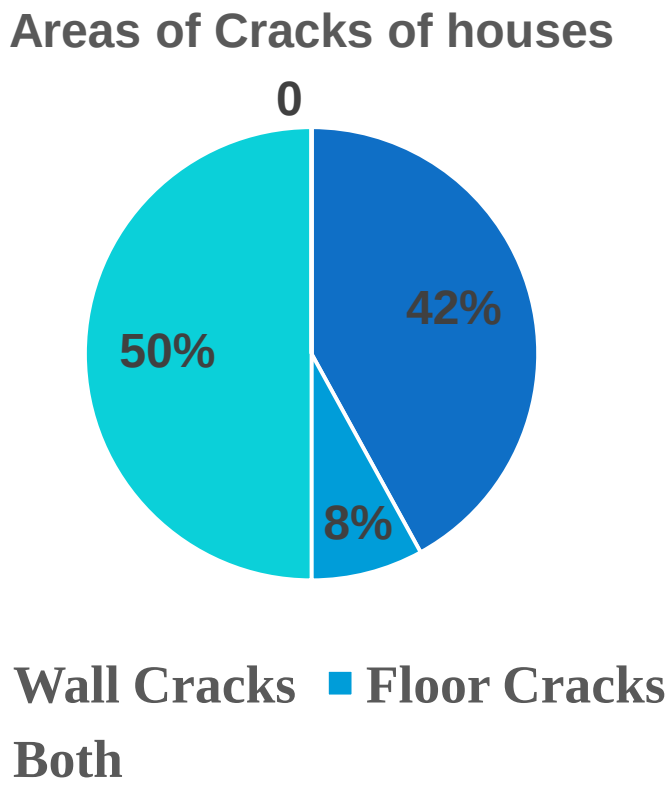

Major ion relationship in August
Ca2++Mg2+ mg/L
HCO3- mg/L
y = 0.1652x + 2.0988
R² = 0.912
0
20
40
60
80
100
120
140
160
0
100
200
300
400
500
600
700
800
900

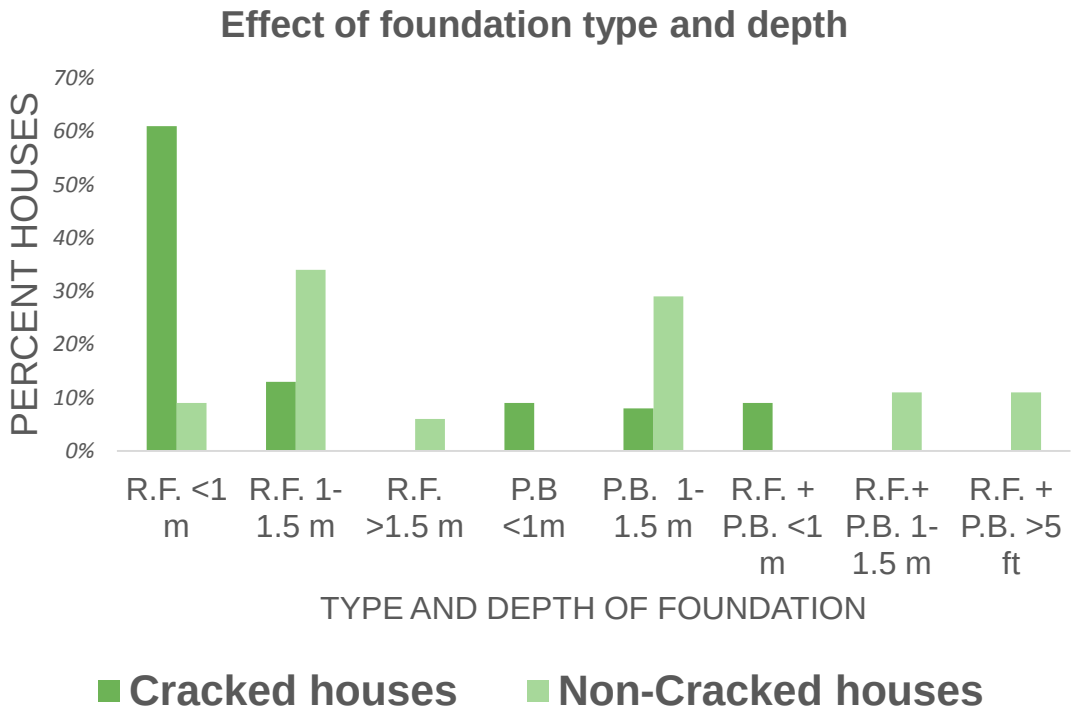

Major ion relationship in September
Ca2++Mg2+ mg/L
HCO3- mg/L
y = 0.2156x - 11.201
R² = 0.9561
0
20
40
60
80
100
120
140
160
0
100
200
300
400
500
600
700
800

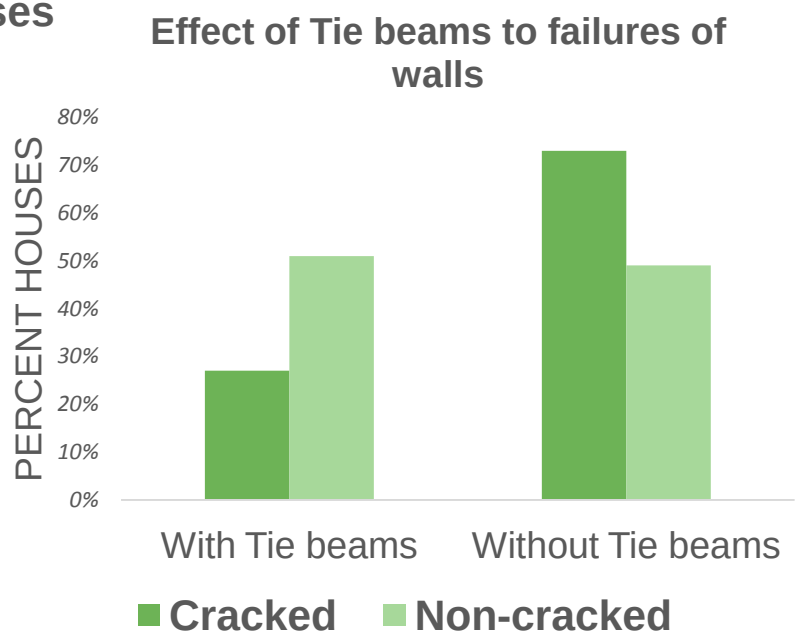
SOCIAL SURVEY

Presence of cracks






Effect of foundation type and depth
PERCENT HOUSES
70%
60%
50%
40%
30%
20%
10%
0%
R.F. <1 m
R.F. 1-1.5 m
R.F. >1.5 m
P.B <1m
P.B. 1-1.5 m
R.F. + P.B. <1 m
R.F.+ P.B. 1-1.5 m
R.F. + P.B. >5 ft
TYPE AND DEPTH OF FOUNDATION
Cracked houses
Non-Cracked houses


Effect of Tie beams to failures of walls
PERCENT HOUSES
80%
70%
60%
50%
40%
30%
20%
10%
0%
With Tie beams
Without Tie beams
Cracked
Non-cracked

CONCLUSIONS

- *Geological mapping revealed the presence of underneath marble band running through the Dodandeniya area with possible solution cavities.*
- *Major ion ratios provide confirmative evidences for dissolution of underneath marble band indicating the possible subsurface cavity formation within the area.*
- *Considering these observations the occurrence of future land subsidence at any time due to the presence of subsurface cavities is postulated.*
- *The flow systems in the area directly linked with the rainfall and hence reactivation of landslide would be triggered again under the presence of intense rainfall.*
- *Since the slip surfaces have already been developed a triggering mechanism either by excess rainfall or subsidence could cause a severe landslide.*
- *Therefore it can be concluded that the Dodandeniya area is* **vulnerable for landslides coupled with subsidence** *triggered by rainfall, human intervention and construction activities.*

RECOMMENDATIONS

- *Conduct further detailed geophysical investigations combined with subsurface drilling to confirm the presence of solution cavities and to demarcate slip surfaces of the landslide*
- *Continuation of the hydro-chemical monitoring studies supported by daily rainfall in local area to obtain a clear picture of the possible hazard due to subsurface dissolution*
- *A vigilant group is expected in the local area if community is planning to stay within the endangered zone*

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THANK YOU..