Tell Identification in the Northern Jordan Valley:
Comparing Methods using Multiple Remotely-Sensed Data Sets

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Purpose of Study:

     1. Determine feasibility and efficacy of refining gross site (tell) data (i.e. location, size) through automated image processing.

           - decreased user supervision.
           - decreased processing time by using standard algorithms and macros.
           - increase recording accuracy of a high number of sites over larger areas.

     2. Determine how remotely sensed datasets differing in spatial and temporal resolution are able to accomplish this.

           - CORONA, Landsat, ASTER imagery
           - several software platforms (ImageJ, ERDAS)
           - assess accuracy/expediency cost

Tells Qa'adan North & South

2007   1970

Tell Rabi'

2007   1970

- JADIS (The Jordan Antiquities Database and Information System) often lacks accurate quantifiable data at the overall site level.

- Site revisits are expensive: Remotely sensed data relatively inexpensive or free.

- Development due to agriculture and housing has often degraded site conditions, limiting even modern imagery for assessing original site metrics.

- Declassified CORONA imagery cheaper than some high-resolution datasets. Precedes 30+ yrs. of development.

Study Region: Eastern Jordan Valley
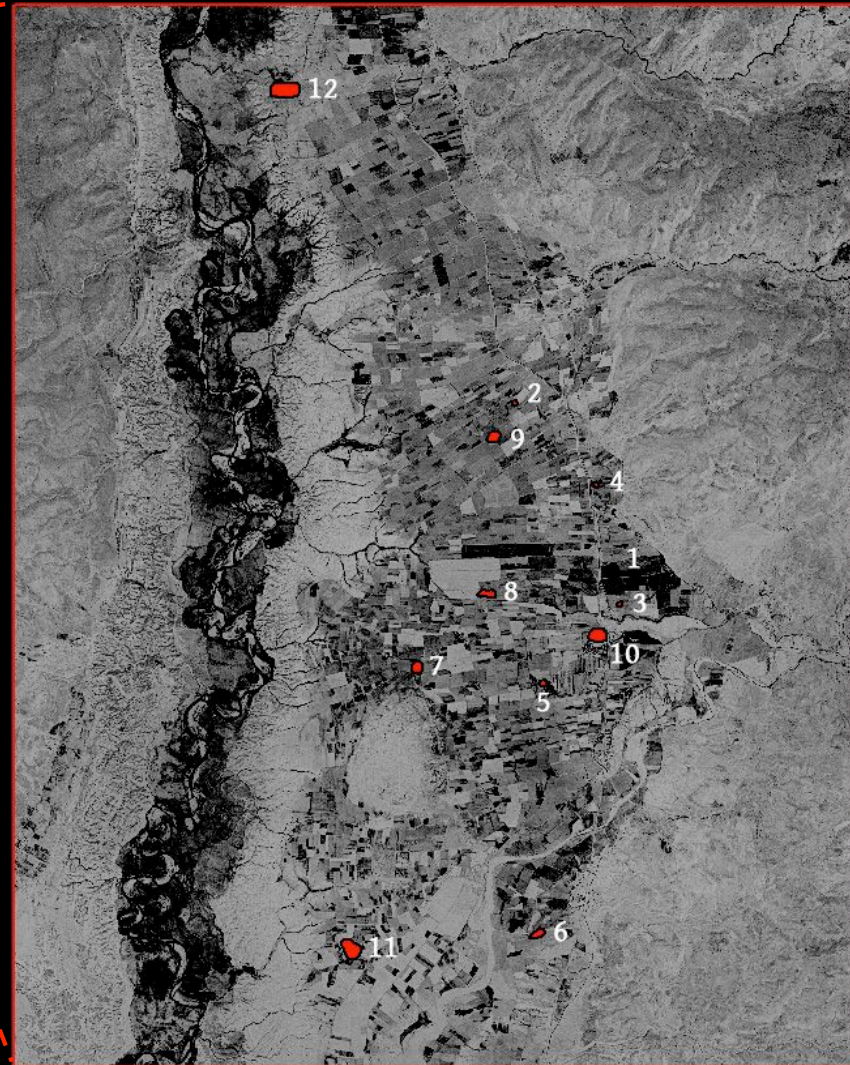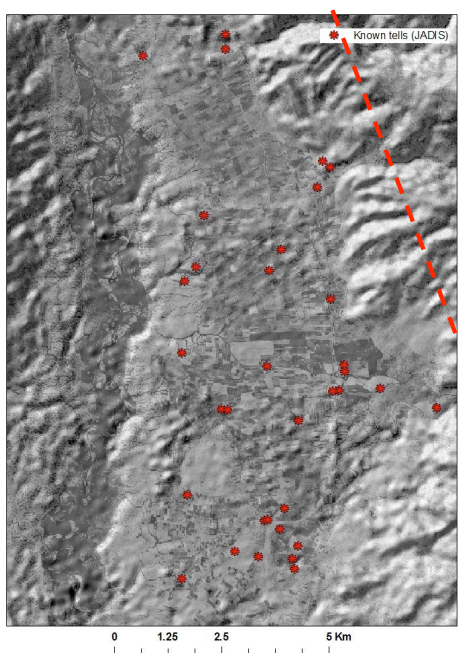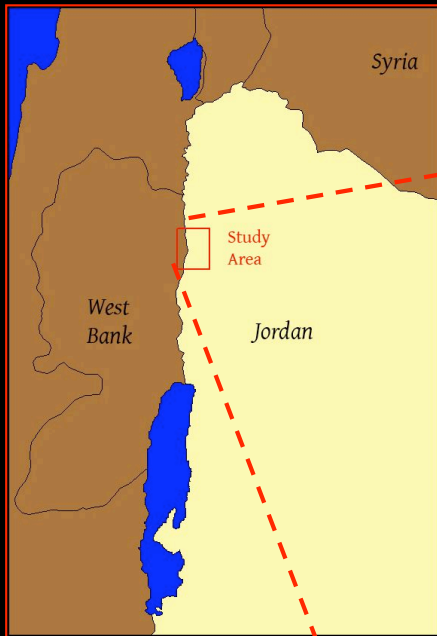
Sites targeted within Study Area:

1. Tell Qa'adan North
2. Tell Ghazala
3. Tell Qa'adan South
4. Tell Adliyeh
5. Tell Fukhar
6. Tell Meleh
7. Tell Rabi'
8. Tell Abu Sarbut
9. Tell Mazar
10. Tell De'ir Alla
11. Tell Muntih
12. Tell As-Sa'idiyeh

= Site boundary based on manual vector tracing.

# Part 1: CORONA Analysis using ImageJ biomedical image analysis software

Stage 1: Digitisation of 12 known sites from JADIS used as test sample for analysis.
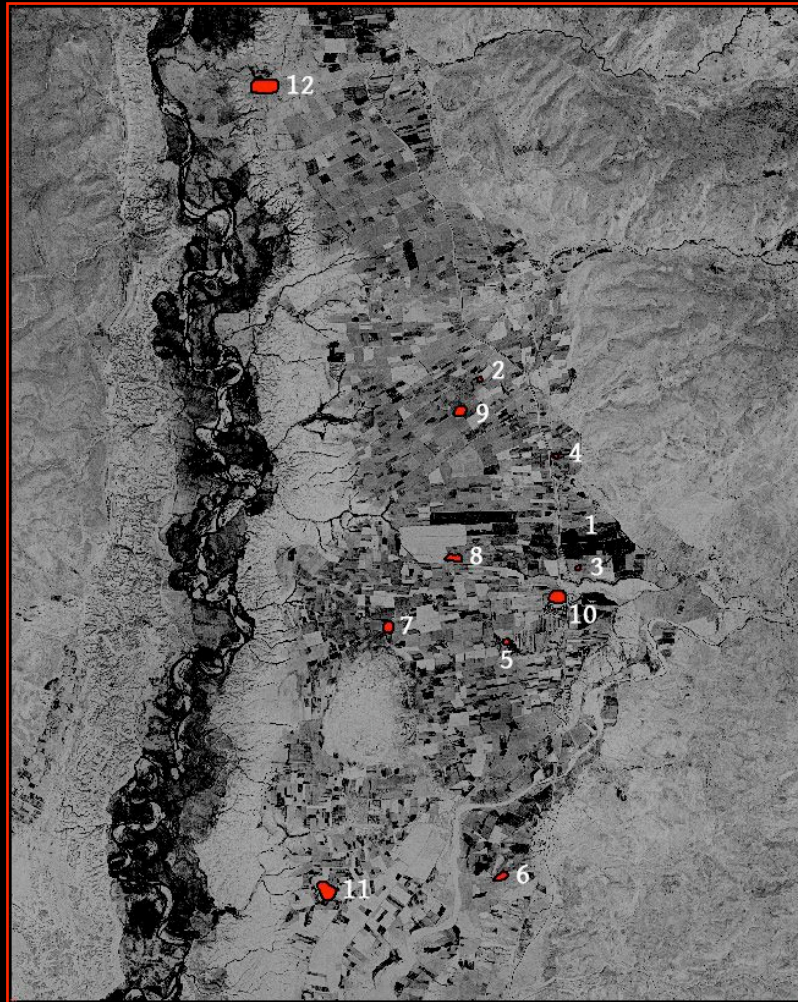

| Number	Site Name	Vector Area (ha)	Vector Perimeter (m)	Raster Area (ha)	Raster Perimeter (m)	Circularity	Areal difference (ha)	Perimeter difference (m)	Area gain
1	Tell Qa'adan North	0.26	186.43	0.31	209.60	0.87	0.04	23.17	17.3%
2	Tell Ghazala	0.43	236.06	0.48	261.42	0.89	0.06	25.36	13.0%
3	Tell Qa'adan South	0.47	253.05	0.53	287.63	0.81	0.06	34.58	13.4%
4	Tell Adliyeh	0.54	267.61	0.60	301.17	0.83	0.06	33.56	10.1%
5	Tell Fukhar	0.76	314.92	0.83	342.99	0.88	0.07	28.07	9.4%
6	Tell Meleh	1.89	552.95	2.03	593.80	0.72	0.14	40.85	7.5%
7	Tell Rabi'	2.15	530.43	2.26	570.42	0.87	0.12	39.99	5.4%
8	Tell Abu Sarbut	2.25	636.99	2.41	688.80	0.64	0.15	51.81	6.7%
9	Tell Mazar	2.46	569.37	2.60	610.27	0.88	0.14	40.90	5.6%
10	Tell De'ir Alla	4.08	738.42	4.27	792.59	0.85	0.19	54.17	4.7%
11	Tell Muntih	5.34	880.82	5.55	950.69	0.77	0.21	69.87	4.0%
12	Tell As-Sa'idiyeh	7.51	1076.3	7.80	1132.95	0.76	0.30	56.65	3.9%
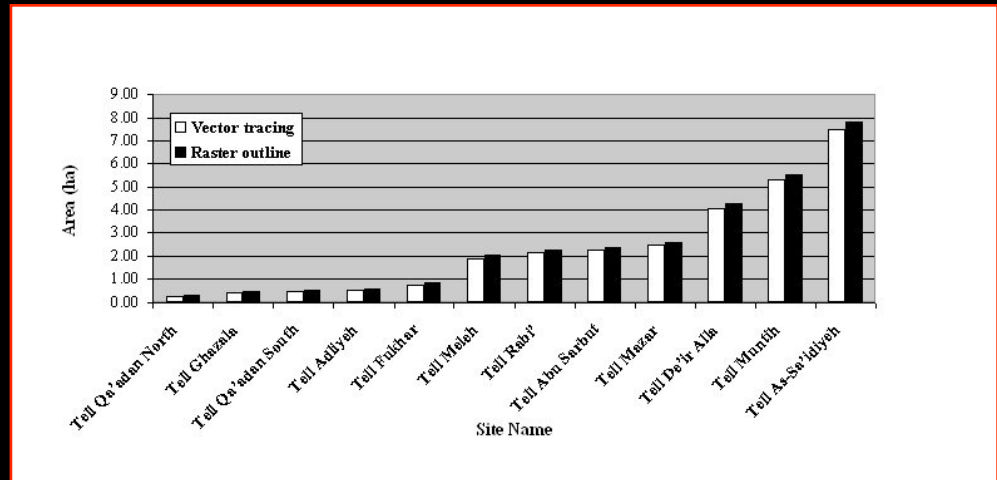
Stage 2: Isolation of individual sites to determine analysis parameters for ImageJ
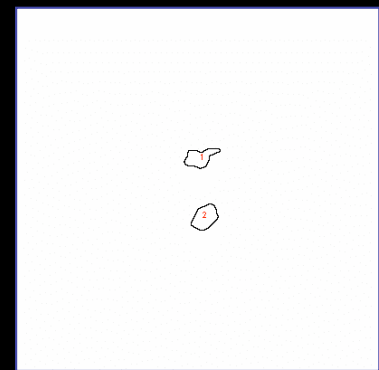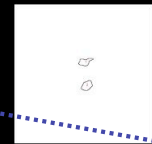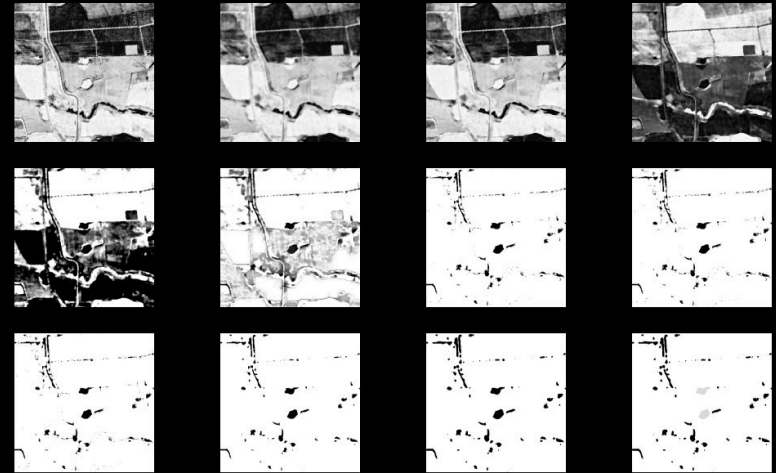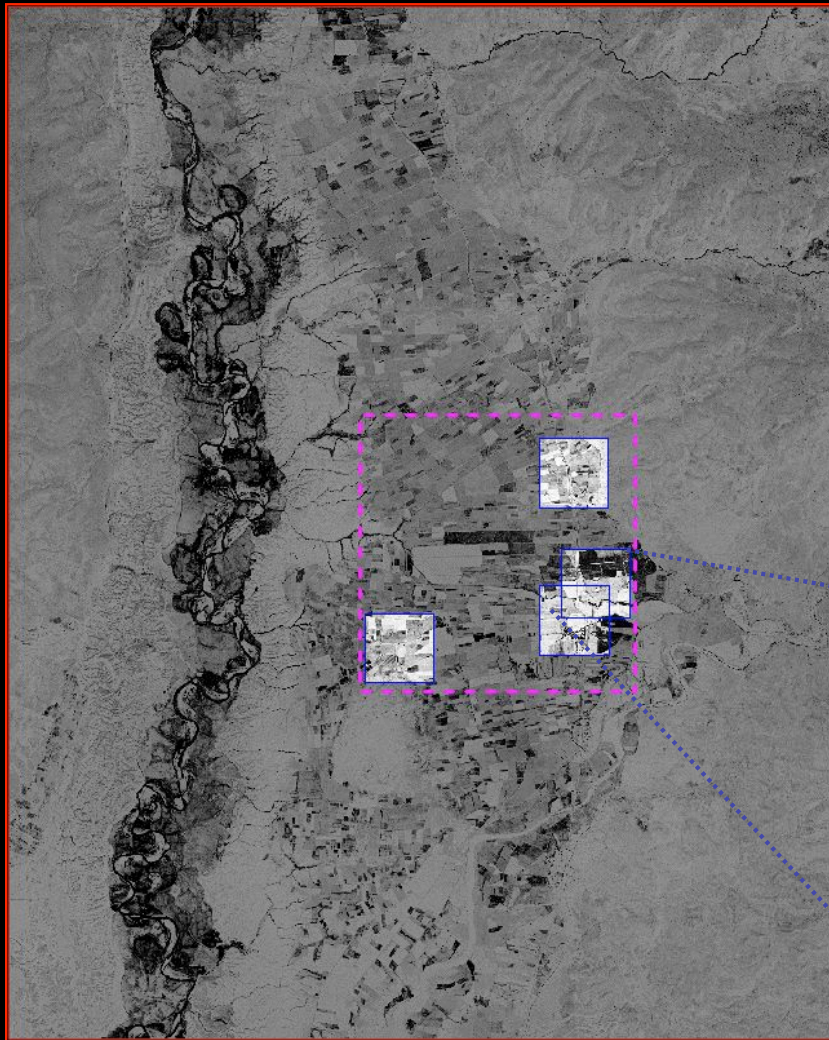
Stage 3: Expand test region to encompass all sites from Stage 2 (4x4 km). Determine ImageJ parameters that allow extraction of all sites together.
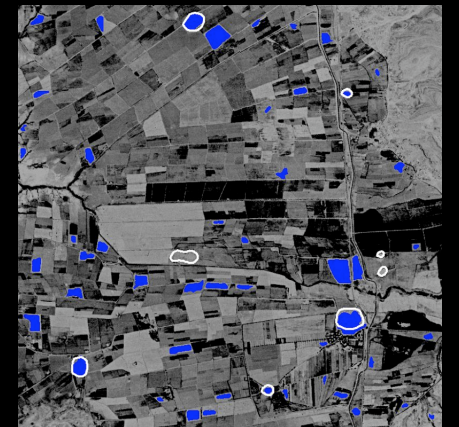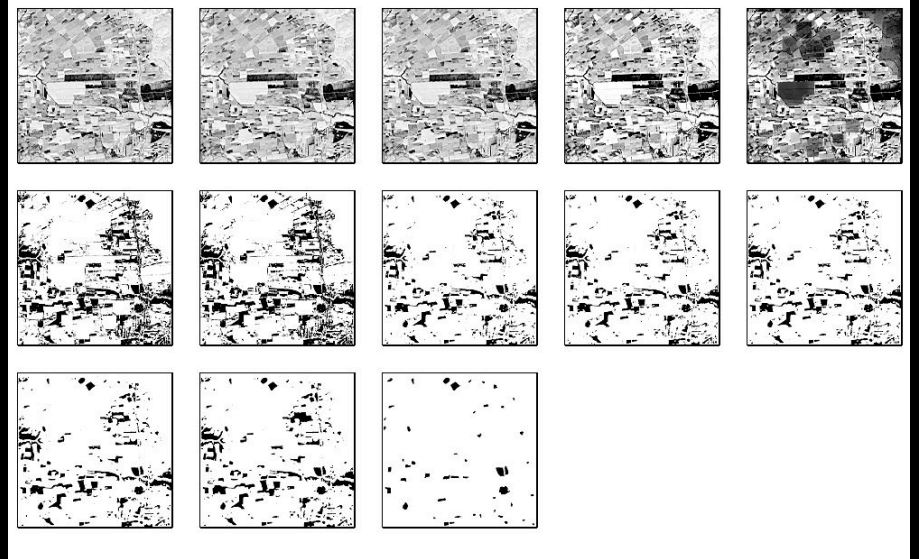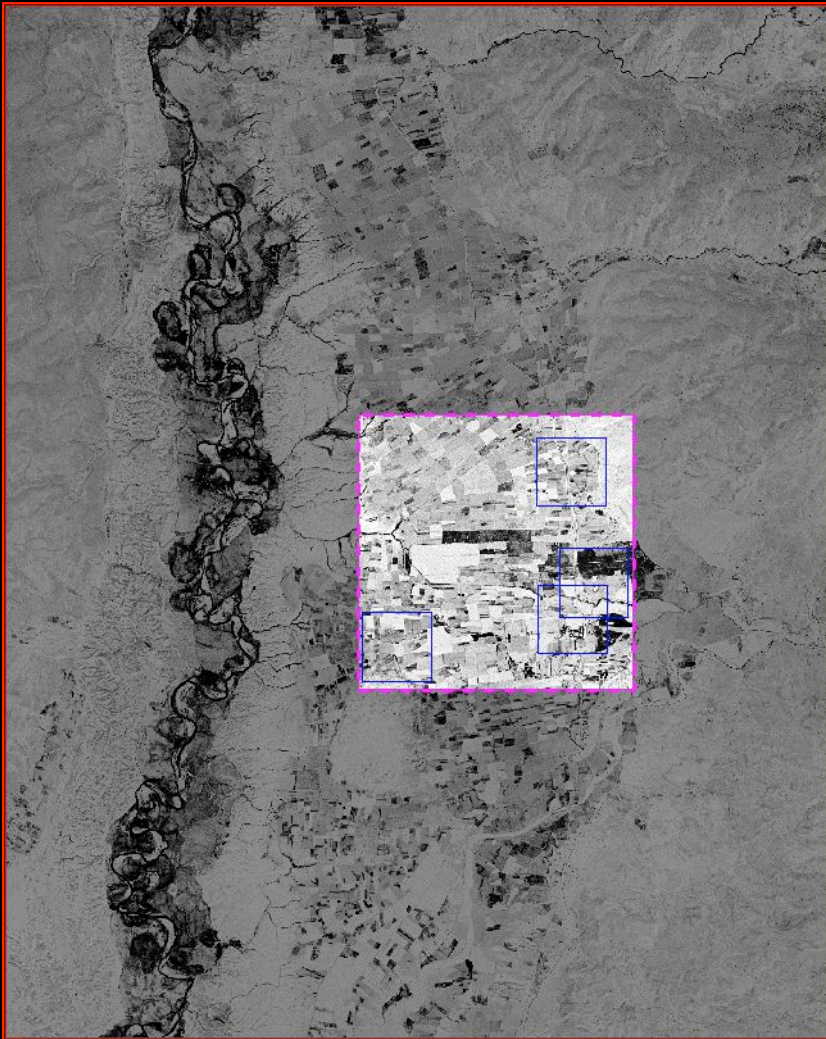
Stage 4: Analysis series run on masked study region. Refinement to optimal reduction parameters.
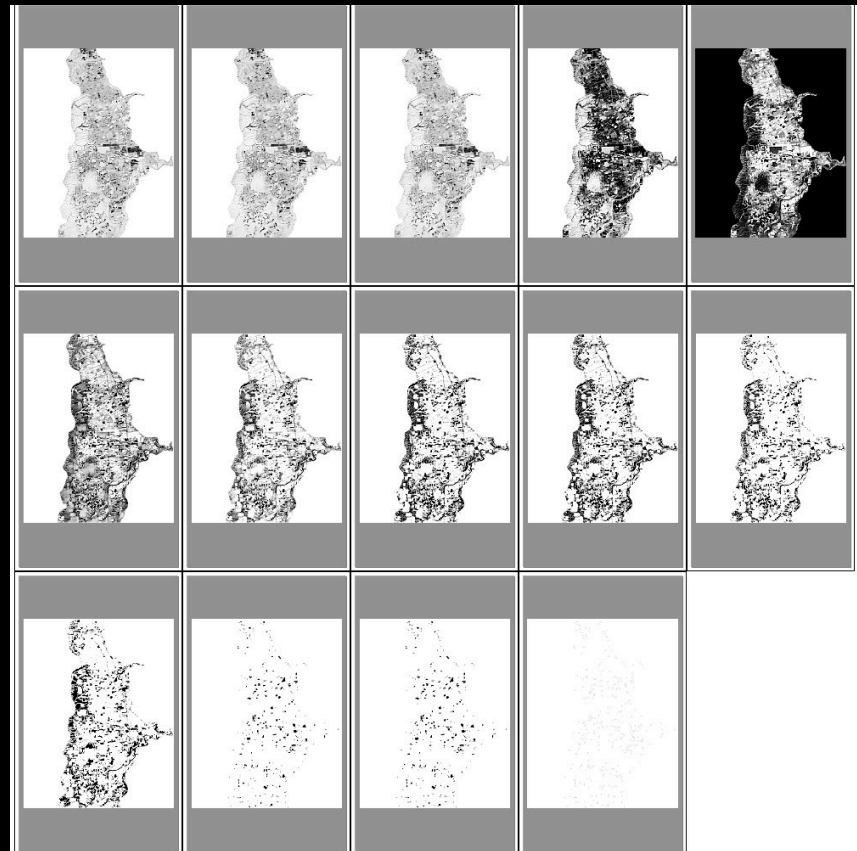
RESULTS

325 Particles isolated in
ImageJ:

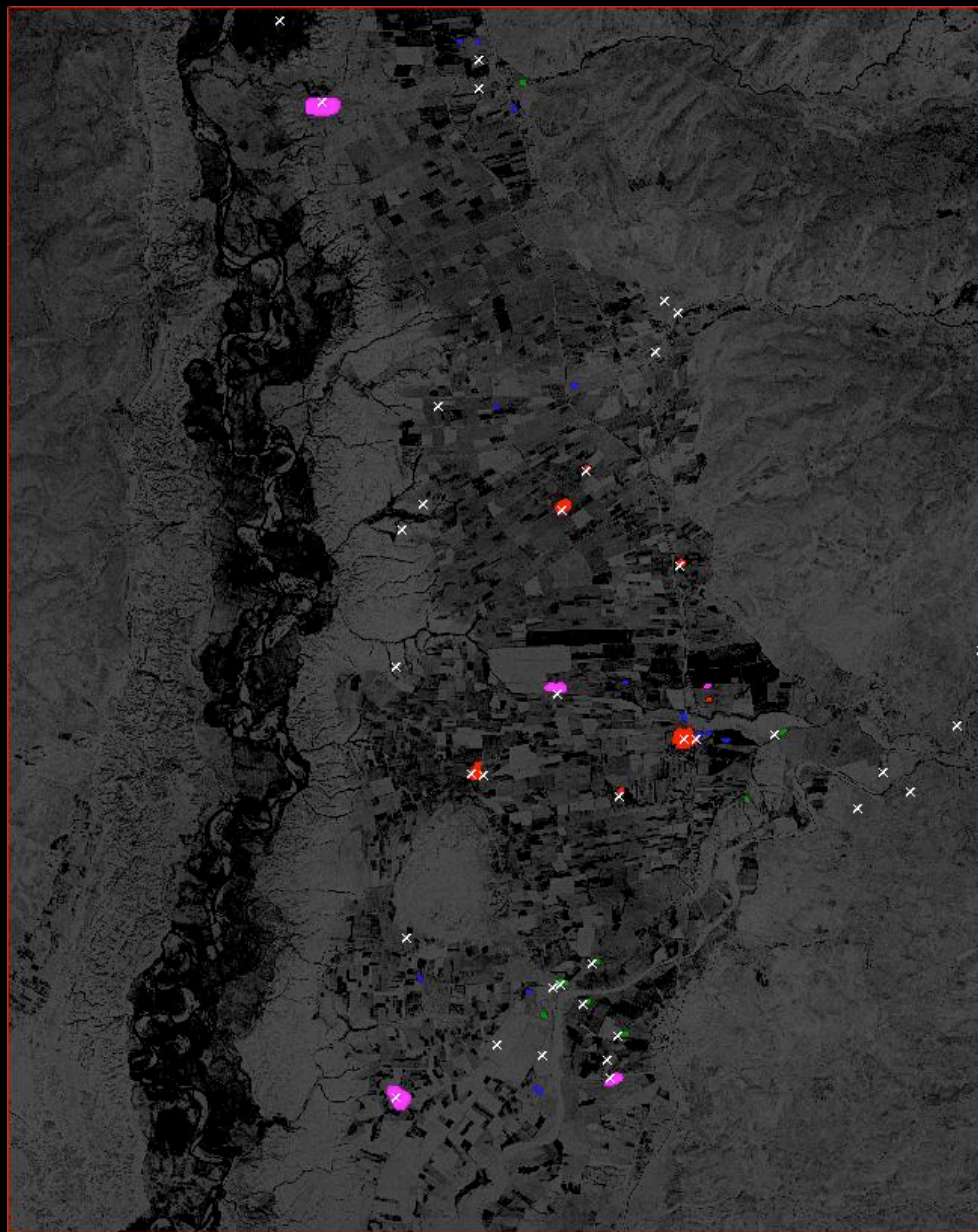7 test group sites identified
9 other JADIS sites identified
12 potential tells
4 modern disturbances
101 natural features
191 agricultural fields

Test Group Site Identified (**7**)

Other JADIS Site Identified (**9**)

Potential Tell Landform (**12**)

Test Group Site Not Identified (**5**)

X   All JADIS Tells

Tabular Results of ImageJ Analysis

Sites from test group re-identified by ImageJ analysis:

ImageJ ID#	Name	ImageJ Results			Manual Rasterised Outlines			
		Area (ha)	Perimeter (m)	Circularity (0-1)	Area (ha)	Perimeter (m)	Circularity (0-1)	Area Loss/Gain
89	Tell Ghazala	0.16	148.99	0.90	0.48	261.42	0.89	-0.32
101	Tell Mazar	1.97	534.66	0.87	2.60	610.27	0.88	-0.63
112	Tell Adliyeh	0.37	227.28	0.90	0.60	301.17	0.83	-0.23
151	Tell Qa'adan South	0.17	153.99	0.91	0.53	287.63	0.81	-0.36
166	Tell De'ir Alla	4.93	1023.01	0.59	4.27	792.59	0.85	0.67
183	Tell Rabi'	1.84	656.73	0.54	2.26	570.42	0.87	-0.42
195	Tell Fukhar	0.22	188.14	0.77	0.83	342.99	0.88	-0.61

JADIS sites identified by ImageJ analysis:

ImageJ ID#	Name	Area (ha)	Perimeter (m)	Circularity (0-1)
14	Tell Keraymeh North	0.17	162.53	0.83
167	Tell Hemmeh West	0.24	219.96	0.62
202	Tell Dhabab	0.16	165.46	0.74
247	Tell Rikabi	0.19	190.81	0.66
255	Tell Asiyeh	0.46	300.06	0.64
257	Tell Bashir	0.13	138.39	0.83
265	Tell Remeilah	0.22	171.07	0.92
267	Tell Abu An-Na'im	0.21	179.60	0.80
273	Tell Ma'adi	0.20	211.92	0.57

Potential site landforms:

| ImageJ ID#	Name	Area (ha)	Perimeter (m)	Circularity (0-1)
5	Mound(?)	0.16	161.32	0.78
6	Mound(?)	0.12	137.78	0.82
20	Mound(?)	0.16	187.53	0.57
58	Mound(?)	0.21	201.42	0.64
69	Mound(?)	0.14	136.92	0.93
141	Mound(?)	0.12	139.25	0.79
159	Mound(?)	0.30	234.6	0.68
168	Mound(?)	0.13	148.99	0.76
170	Mound(?)	0.27	231.67	0.64
172	Mound(?)	0.15	157.78	0.75
254	Mound(?)	0.17	192.28	0.57
263	Mound(?)	0.17	150.46	0.93
285	Mound(?)	0.39	278.24	0.64

Part 2: Classification Analysis of CORONA, Landsat, and ASTER Imagery
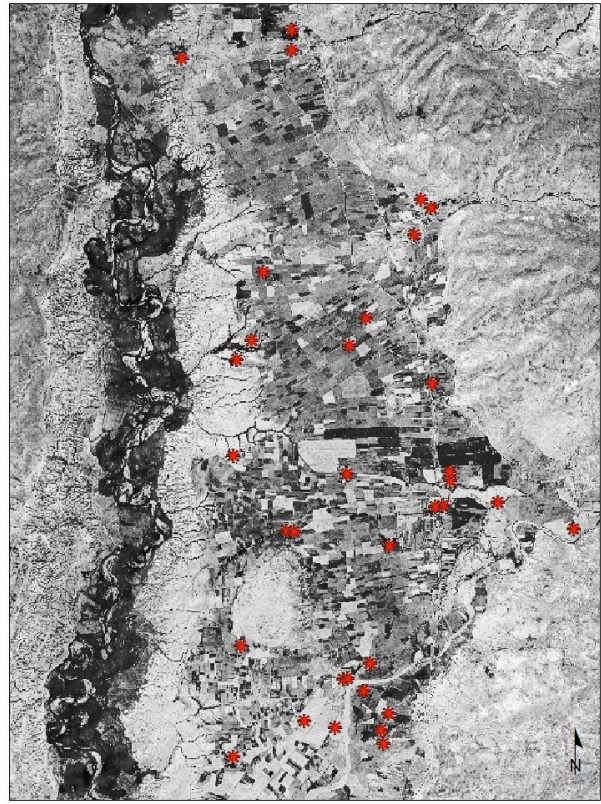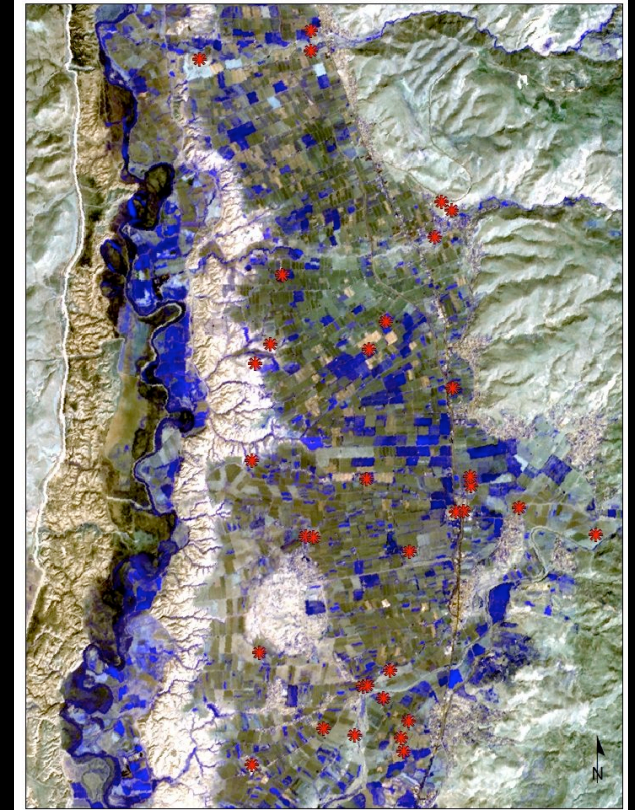
CORONA
1970
2.5m
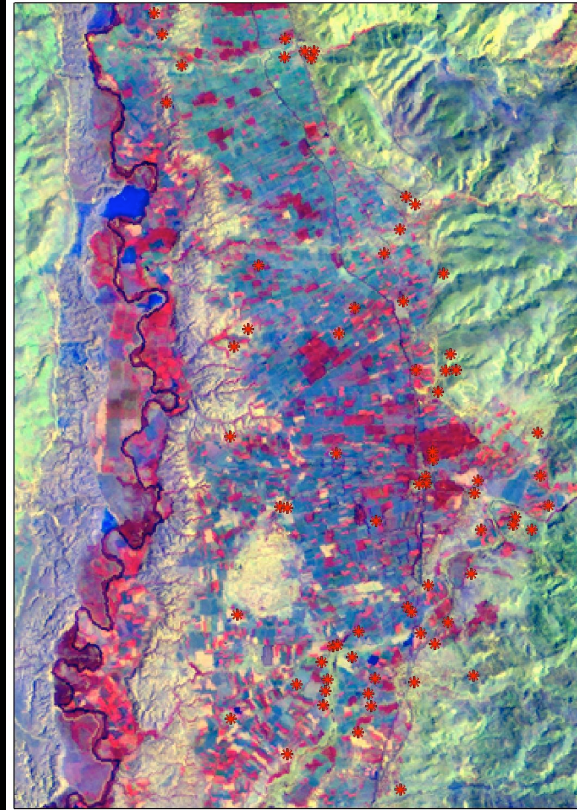
LANDSAT TM
1987
Bands 4,5,6,7
28.5m

ASTER
2002
Bands 4,6,8
30m

	Obtain and process images

| | ISODATA Unsupervised Classification (20) |

| | Supervised Classification |

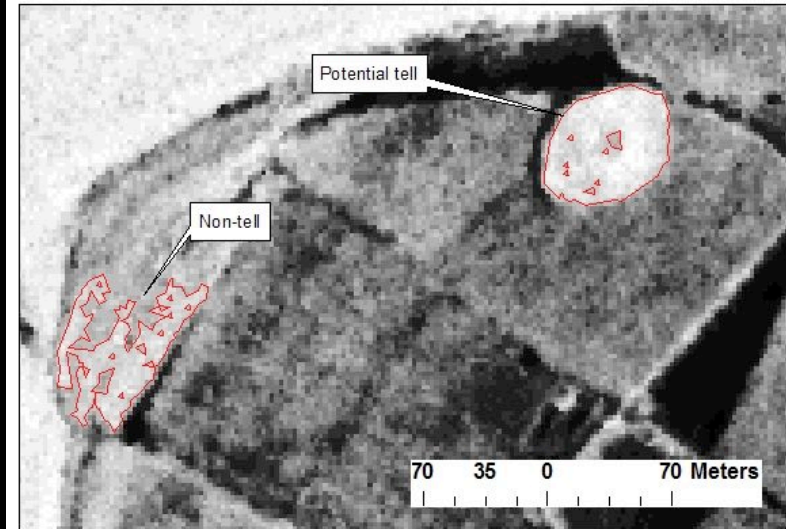| | Eliminate Pixels smaller than Minimum Mapping Unit |

| | Eliminate Obvious Non Tell Polygons |

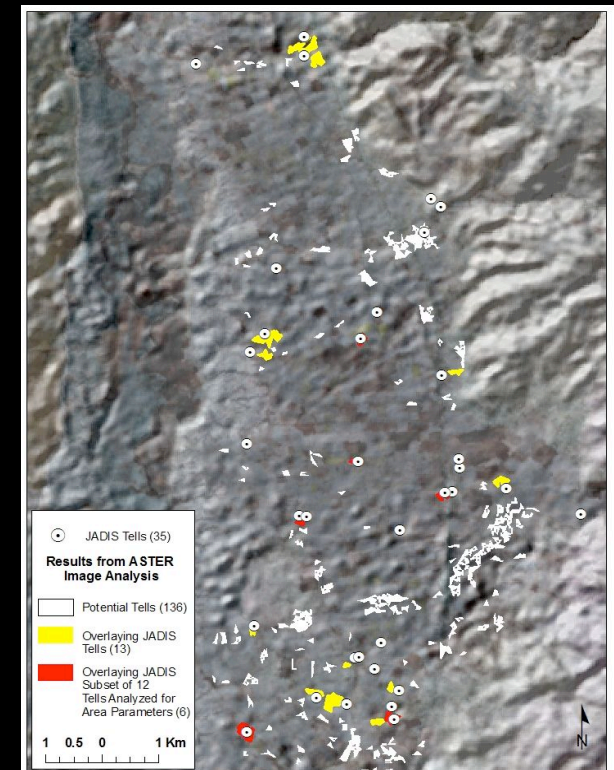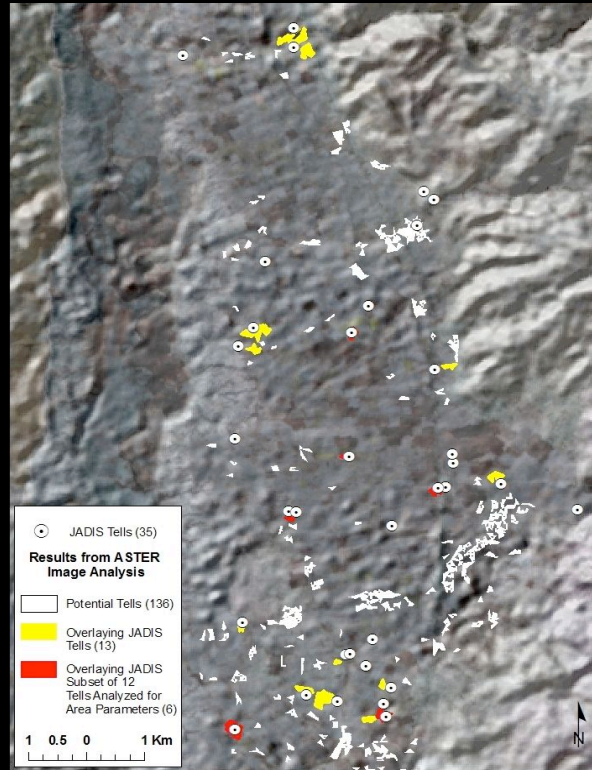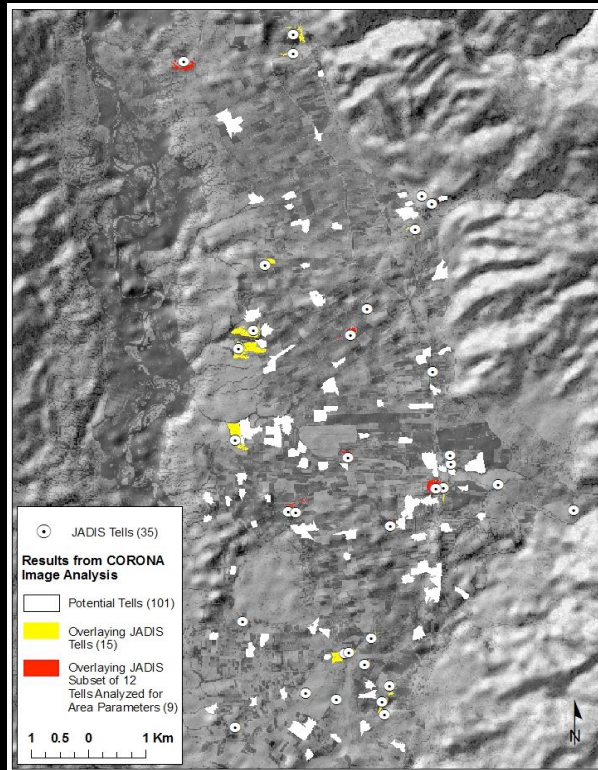| Image	Pixel Size	Minimum Mapping Unit
CORONA	2.5m	0.26 ha
Landsat TM	28.5m	0.5 ha
ASTER	30m	0.5 ha

Potential Tell Locations

Image	Potential tell polygons	Pixel size	Minimum Mapping Unit	Match JADIS tells (35 sites)	Match subset of 12 tell sites
CORONA	129	2.5 m	0.26 ha	24	9
ASTER	105	30m	0.5 ha	18	5
LANDSAT	155	28.5m	0.5 ha	19	6

| Site No	Site Name	Vector Area (ha)	Raster Area (ha)	Corona Area (ha)	Landsat Area (ha)	ASTER Area (ha)
1	Tell Qa'adan North	0.26	0.31	ND	ND	ND
2	Tell Ghazala	0.43	0.48	0.3	ND	ND
3	Tell Qa'adan South	0.47	0.53	0.31	ND	1.71
4	Tell Adliyeh	0.54	0.60	0.53	ND	ND
5	Tell Fukhar	0.76	0.83	0.34	ND	ND
6	Tell Meleh	1.89	2.03	ND	2.81	ND
7	Tell Rabi'	2.15	2.26	2.37	1.67	ND
8	Tell Abu Sarbut	2.25	2.41	0.9	0.99	0.64
9	Tell Mazar	2.46	2.60	2.28	1.27	1.27
10	Tell De'ir Alla	4.08	4.27	4.93	1.93	1.54
11	Tell Muntih	5.34	5.55	ND	5.16	6.39
12	Tell As-Sa'idiyeh	7.51	7.80	2.94	ND	ND
ND = Not Detected						

JADIS Tell Sites
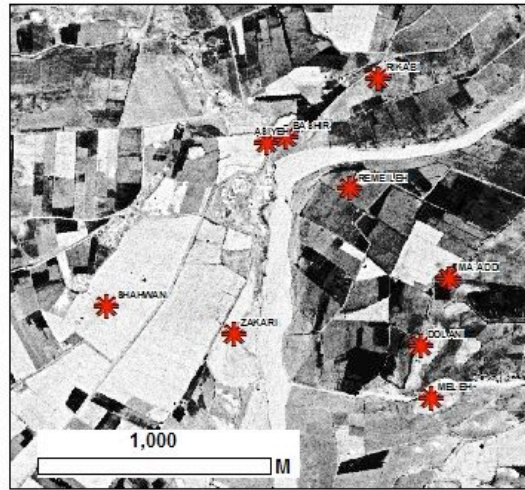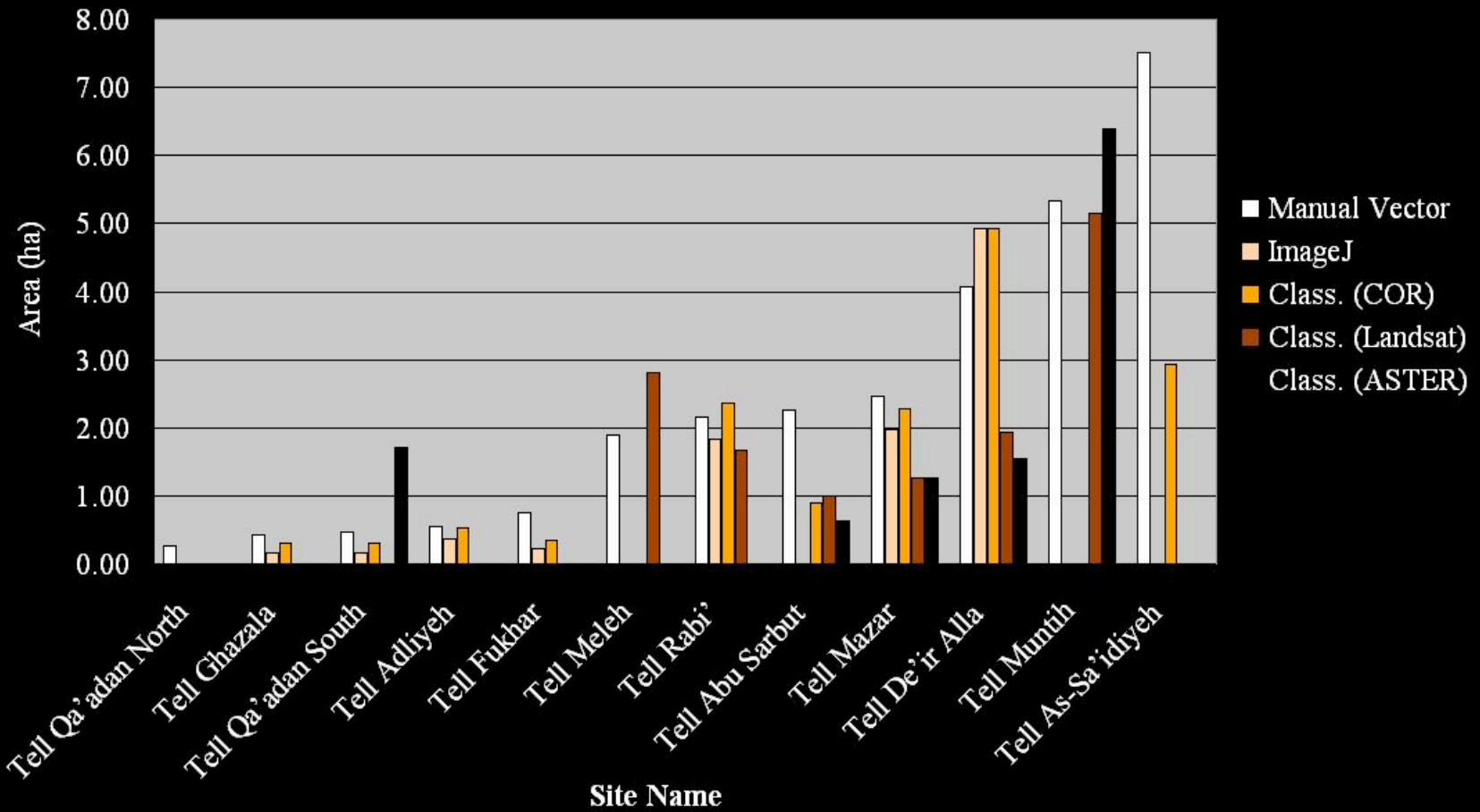
Sites detected with CORONA (2.5m)
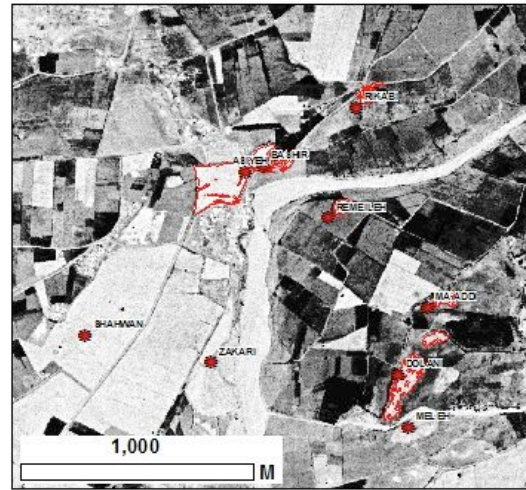
Sites detected with LANDSAT (28.5m)
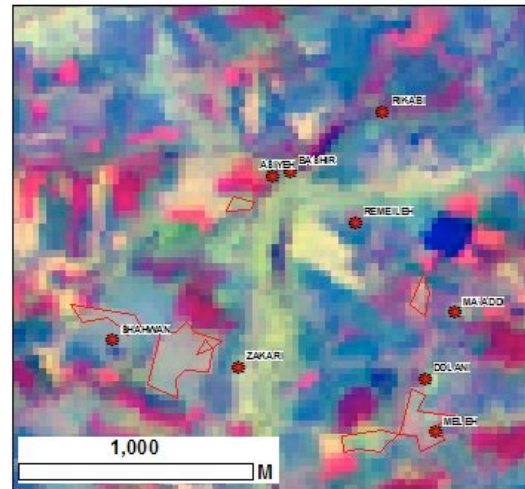
Sites detected with ASTER (30m)
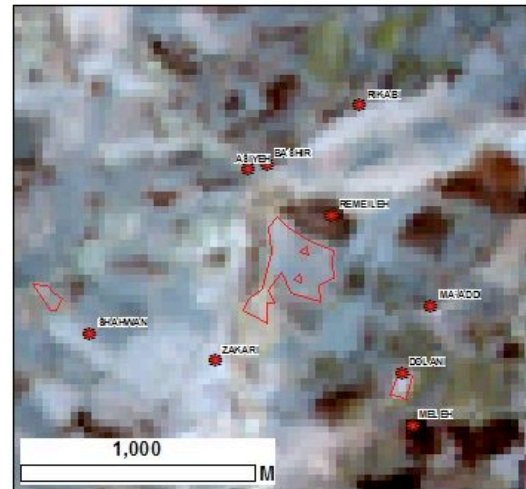
Comparison of Methods for 12 Test Sites

Comparison of Methods

 ImageJ analysis provided results further from original digitised site boundary and location values as test areas increased in size.

       Problems:
              - parameters set in ImageJ may allow ID of only particular sites due to constraining processing factors and nature of imagery itself.

              - factors singled out to isolate sites (size, circularity, spectral signature, etc.) not unique enough for high-resolution results.

 Multispectral Analysis returned encouraging results in terms of locating tells but was not able to refine site boundaries to an acceptable degree.

       Problems:
              - coarse resolution limits accuracy of site delimitation.
              - modern development has, in some cases, obscured expected spectral signature.

Conclusions

Methodological potential for refining tell dimensions and other metric data: An <u>aid</u> rather than <u>unsupervised automation</u>.

Extraction of multiple classes of data possible using CORONA. Not
    limited to built-up features.