Integrating GIS and Remote Sensing Techniques in Kingdom of Bahrain Vegetation Survey

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Presentation Agenda

1. Introduction
2. Study Execution
3. Phase I – Desk Study
4. Phase II – Unsupervised Classification
5. Phase III – Supervised Classification
6. Final Deliverables
7. Conclusions
In 2010 the General Directorate for Statistics of Bahrain undertook a general census in which part of it focused on agriculture and vegetation cover.

GIS and remote sensing (RS) techniques were used for the first time ever in the Kingdom.

The Vegetation Survey utilized high resolution (0.41 m) multi-spectral (near IR + BGR) imagery.

The survey was executed in three (3) phases for entire area for the Kingdom of Bahrain.
Study Execution

1. Desk Study

3 Phases

2. Unsupervised Classification

3. Supervised Classification
Phase I – Desk Study

**Collection and review of existing information of vegetation cultivated and indigenous to Bahrain**
Phase I – Desk Study

Organizations contributing with information and data pertaining to vegetation in Bahrain

- Provided information regarding the land cover and land use.
- Provided information regarding the vegetation type local to Bahrain.
- Provided information regarding the topological features of Bahrain.
- Websites for different Bahraini government agencies were accessed for additional relevant information.
Study Execution

1. Desk Study
2. Unsupervised Classification
3. Supervised Classification

3 Phases
Phase II – Unsupervised Classification
(Calculated by Software)
Phase II – Unsupervised Classification

1. Acquiring high resolution satellite imagery (41cm to 50cm)

2. Apply Normalized Difference Vegetation Index (NDVI)

3. Perform Unsupervised Classification
Phase III – Supervised Classification (Human-guided)

**Field survey**
- 179 sites were randomly selected
- A map showing a sample of the collected field survey data
- 5 GIS specialists
- 20 sites covered per day
- GPS receivers were used

**Supervised Classification**
- NDVI image
- 75 different vegetation types found such as palm trees, mangroves, tomatoes, etc.
- An example of the vectorized vegetation classification map

**Accuracy Assessment**
- Ground truth data for 110 randomly selected locations representing the various classes of vegetation were obtained
- The measured accuracy was 87% accurate which is according to international standards is quite an acceptable level

- Accuracy Assessment in ERDAS Imagine
  - Make a file in Excel with ONLY the X-Y coordinates for your GPS points collected in field

The page contains a flowchart showing the process from field survey to supervised classification and finally accuracy assessment. Each step is illustrated with relevant images and descriptions.
Final Deliverables

1. Total vegetation cover
2. Total agricultural crops
3. A smart GIS location maps of the various vegetation
4. A list of all vegetation types and their areas
5. The general health of the vegetation
Results

A range of statistical results obtained from the vegetation Survey. Many of these results were also produced as Thematic Maps, while some data was produced in tables.

A sample of vegetation classes

<table>
<thead>
<tr>
<th>Area</th>
<th>Dunam</th>
<th>Km Sqr.</th>
<th>Hectares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total vegetation cover</td>
<td>61216.25</td>
<td>61.216</td>
<td>6121.625</td>
</tr>
<tr>
<td>Total agricultural crops</td>
<td>10922.365</td>
<td>10.922</td>
<td>1092.23</td>
</tr>
</tbody>
</table>
## Results

A sample of vegetation classes (documenting 75 types)

<table>
<thead>
<tr>
<th>Area in SqrKM</th>
<th>Classes</th>
<th>تصنيفات</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.005</td>
<td>Date Palms</td>
<td>نخيل</td>
</tr>
<tr>
<td>0.978</td>
<td>Mixed Trees</td>
<td>أشجار متنوعة</td>
</tr>
<tr>
<td>1.644</td>
<td>Mixed Orchard</td>
<td>أشجار فواكه متنوعة</td>
</tr>
<tr>
<td>0.365</td>
<td>Kanar</td>
<td>كنار</td>
</tr>
<tr>
<td>0.356</td>
<td>Almonds</td>
<td>لوز</td>
</tr>
<tr>
<td>0.006</td>
<td>Tangerine</td>
<td>ترنتج</td>
</tr>
<tr>
<td>0.006</td>
<td>Orange</td>
<td>برتقال</td>
</tr>
<tr>
<td>0.003</td>
<td>Banana</td>
<td>موز</td>
</tr>
<tr>
<td>0.042</td>
<td>Lemon</td>
<td>ليمون</td>
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<tr>
<td>0.036</td>
<td>Mango</td>
<td>مانجو</td>
</tr>
<tr>
<td>0.229</td>
<td>Neem</td>
<td>شجر النيم</td>
</tr>
<tr>
<td>0.285</td>
<td>Sweet Tamarind</td>
<td>تمر هندي</td>
</tr>
<tr>
<td>0.056</td>
<td>Sour Tamarind</td>
<td>صباغ حامض</td>
</tr>
<tr>
<td>0.129</td>
<td>Eucalyptus</td>
<td>شجر الكينا</td>
</tr>
<tr>
<td>0.036</td>
<td>Sapodilla</td>
<td>جيجو</td>
</tr>
<tr>
<td>0.098</td>
<td>Papaya</td>
<td>باباي</td>
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<tr>
<td>0.300</td>
<td>Lasursa - Bambar</td>
<td>يمير</td>
</tr>
<tr>
<td>0.431</td>
<td>Argula</td>
<td>جرجير</td>
</tr>
<tr>
<td>0.777</td>
<td>Barley</td>
<td>شعير</td>
</tr>
<tr>
<td>0.233</td>
<td>Beet Root</td>
<td>فجل</td>
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<tr>
<td>0.020</td>
<td>Bitter Gourd</td>
<td>فرع (صنف 1)</td>
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<td>Bottle Gourd</td>
<td>فرع (صنف 2)</td>
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<td>0.033</td>
<td>Broccoli</td>
<td>بروكلين</td>
</tr>
<tr>
<td>0.253</td>
<td>Cabbage</td>
<td>ملفوف</td>
</tr>
<tr>
<td>0.097</td>
<td>Carrot</td>
<td>حزم</td>
</tr>
<tr>
<td>0.303</td>
<td>Cauliflower</td>
<td>قنابيط</td>
</tr>
<tr>
<td>0.175</td>
<td>Chard</td>
<td>سلك</td>
</tr>
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</table>
Results

A zoomed-in view of some vegetation classes
The General Health of Agricultural Crops

A satellite imagery in infra-red showing the general health of mangroves

Healthy mangroves

Unhealthy mangroves

A satellite imagery in infra-red showing the general crops health

Healthy crops

Unhealthy crops

Classified vegetation

Classified vegetation (mangroves)
Conclusions

1) The objective of vegetation survey is achieved (mapping vegetation cover of Bahrain).

2) The project has been a great success to expand research program to cover additional RS projects and applications to include other inputs, such as weather and soils data.

3) To sum up, “iGA” is able to build and use the necessary GIS infrastructure in Bahrain and exploit the joint GIS and RS analysis system to support agricultural statistics and likely crop monitoring activities.