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Operation SABOT and Illicit Crop Information Management Using Satellite Imagery

RADARSAT International
Richmond, British Columbia

TECHNICAL REPORT
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Executive Summary

This technical report provides a summary of a pilot project carried out by RADARSAT International for the RCMP Drug Enforcement Branch, under Operation SABOT, to demonstrate the potential for the application of high resolution satelite imagery and related spatial analysis to the RCMP's efforts to eradicate marihuana outdoor grow operations.
This project involved two seperate but complementary streams-development of geographical information systems (GIS) to determine areas with the highest potential for marihuana growth, and Image Analysis of these potential sites to further interpret images. Thereby either supporting or refuting the idea that marihuana is being grown in the specific locations. Once grow locations are confirmed both in the imagery and through the GIS analysis, final validation can take place via aerial reconnaissance. Through the steps of satellite image analysis and cross correlation with the GIS data layers, the analysis process takes us from a list of *potential* sites, to *probable* sites, thereby aiding in the location of outdoor marihuana grow operations.

With the planting methods being employed in the study areas chosen, the image spectral and interpretation analysis did not produce favorable results, mainly due to insufficient imaging resolution. The present resolution of the multi-spectral imagery is four metres; however, efforts are underway to analyze an integrated product of the panchromatic (1m resolution) and multi-spectral images that will have a higher overall resolution.

In contrast, results from the GIS were favorable and illustrated that a very good first attempt at locating probable marihuana grow areas could be achieved. Ground verification of actual grow operations was closely correlated to the locations predicted by the GIS analysis of spatial overlays, thereby demonstrating the utility of using a GIS to locate potential illicit crop areas. While eradication and prosecution of outdoor grow operations can best be carried out using traditional methods and approaches, the integrated solution of GIS and, in future, high resolution imagery, will provide an effective non-invasive method of identifying illegal outdoor marihuana grow sites.

Sommaire

Le présent rapport technique décrit sommairement le projet pilote réalisé par RADARSAT International pour la Sous-direction de la police des drogues de la GRC, dans le cadre de l'Opération SABOT, pour démontrer le potentiel de l'imagerie par satellite à haute résolution et de l'analyse spatiale connexe en matière de lutte contre la culture extérieure de la marihuana.

Le projet était divisé en deux éléments complémentaires - d'une part, l'élaboration de systèmes de renseignements géographiques (SRG) pour déterminer les régions au potentiel de culture de marihuana le plus élevé, et d'autre part l'analyse d'images de ces régions pour confirmer ou infirmer l'idée que de la marihuana y est cultivée. Une fois les régions de culture confirmées par l'analyse des images et des SRG, il est possible de faire la vérification finale par reconnaissance aérienne. Grâce à l'analyse des images par satellite et à la corrélation croisée avec les couches de données des SRG, le processus analytique permet de passer d'une liste de sites *potentiels* à une liste de sites *probables,* ce qui aide à localiser les lieux de culture extérieure de marihuana.

En raison des méthodes de plantation utilisées dans les régions choisies pour l'étude, l'analyse spectrale et l'interprétation des images n'ont pas donné de résultats positifs, surtout à cause de la résolution insuffisante des images. La résolution actuelle de l'appareil d'imagerie spectrale est de quatre mètres; cependant, on travaille présentement à l'analyse des images panchromatiques (résolution de 1 m) et multispectrales combinées, dont la résolution globale sera plus élevée.

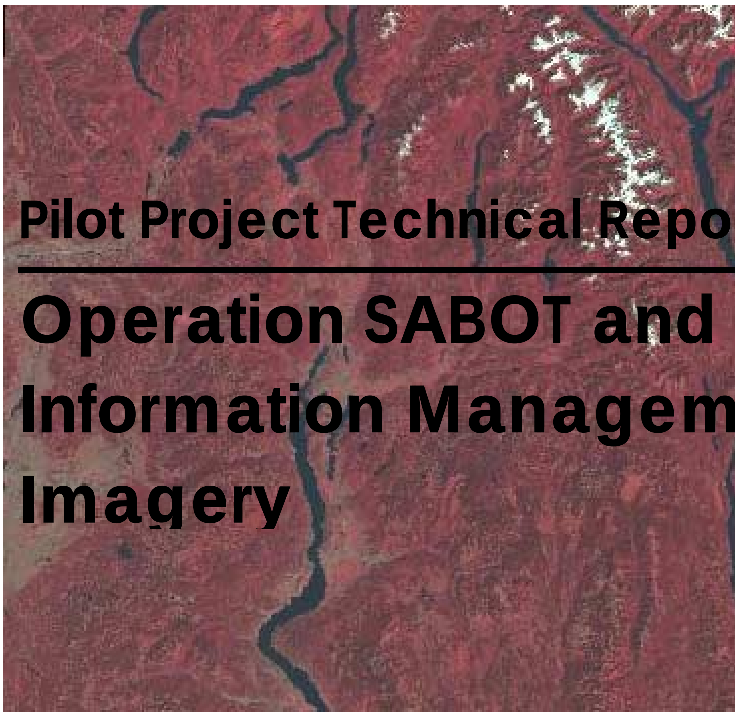
Par contre, les résultats de l'analyse des SRG ont été favorables et ont permis de démontrer dès la première tentative qu'il était possible de détecter les lieux probables de culture de la marihuana. On a vérifié, au sol, les lieux de culture réels, qui étaient reliés étroitement aux lieux prédits par l'analyse SRG des cartes satellites transparentes, ce qui a prouvé l'utilité d'un SRG pour localiser les zones potentielles de culture illégale. Même si les méthodes et les approches traditionnelles sont les plus efficaces en ce qui concerne l'élimination des lieux de culture extérieure et la poursuite des cultivateurs, l'intégration des SRG et de l'imagerie haute résolution offrira une méthode efficace et discrète de localisation des lieux de culture extérieure de la marihuana.

RCMP Sensitive – 3rd Party Rule

RADARSAT INTERNATIONAL

PROJECT TECHNICAL REPORT #P2000-064

07 December, 2000



Pilot Project Technical Report

Operation SABOT and Illicit Crop Information Management Using Satellite Imagery

submitted to

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1.0 Introduction

This technical report provides a summary of a pilot project carried out by RADARSAT International for the RCMP Drug Enforcement Branch, under Operation SABOT, to demonstrate the potential for the application of high resolution satellite imagery and related spatial analysis to the RCMP's efforts to eradicate marihuana outdoor grow operations.

1.1 Project Background

In early March of 2000, RADARSAT International and Corporal Tom Howell of the RCMP Drug Enforcement Branch (DEB) began discussions around the feasibility of using remote sensing together with geographic information systems (GIS) for monitoring illicit crops in southern British Columbia. Efforts to detect and eradicate outdoor marihuana grow operations represent a significant cost to the RCMP. In 1999, an eight-day eradication mission, which yielded approximately seven tonnes of marihuana, cost the RCMP approximately $19,000. This figure does not include any costs for the use of the aircraft.

The potential benefits to the DEB of using satellite imagery and GIS are best understood by comparing current techniques employed through Operation SABOT with those used in this pilot project: Efforts to-date have exploited a limited degree of intelligence to guide DND-provided aircraft to outdoor grow operations. This has resulted in the project personnel employing a "cold hit" process, where scarce and expensive resources (aircraft and personnel) are focused on searching for outdoor marihuana grow operations rather than eradicating them. The impact on the volume of illegal drugs eradicated has therefore been limited to the number of grow operations that could be discovered via a cold hit (a near-random process). Because of the nature of the cold hit process, however, it has been difficult to actually quantify the success of the overall project in terms of marihuana eradication in the project area.

In contrast, the approach taken in this pilot project was proactive rather than reactive. The latest in high resolution satellite imagery, together with other spatial information, were used in combination with mapping technologies to identify probable grow sites in the project area.

High resolution satellite imagery and GIS technologies are well suited for mapping of outdoor grow operations. By compiling, within a GIS framework, various data layers and representing variables important for identifying marihuana grow operations (e.g., elevation, proximity to water supply), the analyst can identify potential grow operation sites. Further analysis of satellite imagery of these potential sites allows the RCMP to focus their eradication efforts on qualified probable sites.

1.2 Project Objectives

1. To demonstrate the effectiveness of spatial analysis in identifying areas which have a high probability of containing an outdoor marihuana grow operations;
2. To quantify the extent of grow operations in the test region and the cost-effectiveness of the project in utilizing the resources expended to eradicate the grow operations discovered;
3. To make recommendations for future use of the demonstrated geomatics technology for this application.

2.0 Satellite Imagery Specifications

This section describes the satellite imagery used in the project and its ability to provide information to monitor marihuana grow activity in the interior of British Columbia.

2.1 IKONOS Satellite Characteristics

Launched in 1999, Space Imaging's IKONOS is the world's first commercial high resolution multi-spectral remote sensing satellite. IKONOS is equipped with state-of-the-art sensors capable of capturing imagery at a spatial resolutions comparable to airphotos (1 metre and 4 metres). This unique sensor has the capacity to fulfill data requirements for a myriad of applications ranging from precision agriculture to urban planning and map updating.

Figure 1 Copper Mountain, Colorado

Figure 1 shows a 4-meter resolution false-colour IKONOS image of a golf course (bright red) and lower ski runs near Copper Mountain, Colorado. This image highlights differences in water and chlorophyll content between the turf of the golf course and the trees on the slopes above. Since marihuana plants require irrigation, this image illustrates the kind of results expected from the pilot project imagery.

Multi-spectral optical sensors such as SPOT, LANDSAT, and IKONOS collect the energy reflected from the Earth's surface at wavelengths roughly equivalent to those which are detected by our eyes. These sensors capture the Earth's reflected energy from several wavelengths.

Table 1 The IKONOS sensor is sensitive to the following wavelength bands:

Band	*Wavelenth*
Panchromatic (1 metre resolution)	0.45 - 0.90 micrometers
Multi-Spectral (4 metre resolution)	
♦ Blue	0.45 - 0.52 micrometers
♦ Green	0.52 - 0.60 micrometers
♦ Red	0.63 - 0.69 micrometers
♦ Near infra-red	0.76 - 0.90 micrometers

Each band represents a unique picture of the Earth's surface and it can be interpreted individually or in combination with other bands to provide different types of information. Image processing techniques make it possible to combine these bands into a colour image of the land surface for effective analysis.

The 4-meter multi-spectral data is excellent for a variety applications that require specific information of the ground surface. The near infra-red band in particular is used to evaluate plant condition since this band responds to water content, a prime indicator of plant vigor— the higher the water content, the greater the surface reflectance and hence the brighter the plants appear in an image (see Figure 1).

The IKONOS sensor records imagery of a ground swath approximately 11KM x 11KM and has a revisit time to the same location of approximately 3 – 5 days. Since optical imagery relies on cloud free conditions, the frequent revisit of the IKONOS satellite increases the chance that imagery can be collected for a particular area of interest in a given time frame.

2.2 IKONOS Image Acquisition Plan

For this pilot project, IKONOS multi-spectral imagery was planned over four sites in the southern interior of BC for the last week of July and first week of August. This acquisition schedule (detailed in Table 2) was developed to support the monitoring of marihuana crops at maturity and before the harvest period.

Table 2 IKONOS Satellite Imagery Acquisition Plan

Location	*Scene Coordinates (Upper left)*	*Image Date*
1. Seymour Arm	-119.302 W, 51.36 N	August 17,2000
2. Slocan Valley	-117.611 W, 49.88 N	August 9, 2000
3. Upper Kettle	-118.967 W, 49.66 N	August 17, 2000
4. Christina Lake	-118.374 W, 49.30 N	August 2, 2000

3.0 Project Methodology

3.1 Overview

Project implementation included a GIS development and Image Analysis as separate but complementary streams (illustrated in Figure 2). The overall objective was to successfully locate and validate outdoor marihuana grow operations. For the purposes of this project, four areas of interest were chosen prior to GIS development. In an operational environment, however, the GIS would be developed first and used as a tool to identify probable grow areas. The results of the GIS analysis would then be used to plan the image acquisitions.

The objectives of the two streams, GIS Analysis and Image Analysis, were:

1. To develop the GIS and to incorporate the many data layers (described in Section 3.4) required to determine the areas with the most potential for marihuana growth. Using the spatial overlay capabilities of a GIS, maps showing potential sites of illicit crops can be identified.
2. To focus on the image analysis of the potential sites and further interpret the images to either support or refute the idea that marihuana is being grown in the specific locations, substantiated by ground truth information.

With this rationale, once the grow locations have been confirmed both in the imagery and through the GIS analysis, final validation can take place via aerial reconnaissance prior to eradication.

Through the steps of satellite image analysis and cross correlation with the GIS data layers, the analysis process takes us from a list of *potential* sites, to *probable* sites.

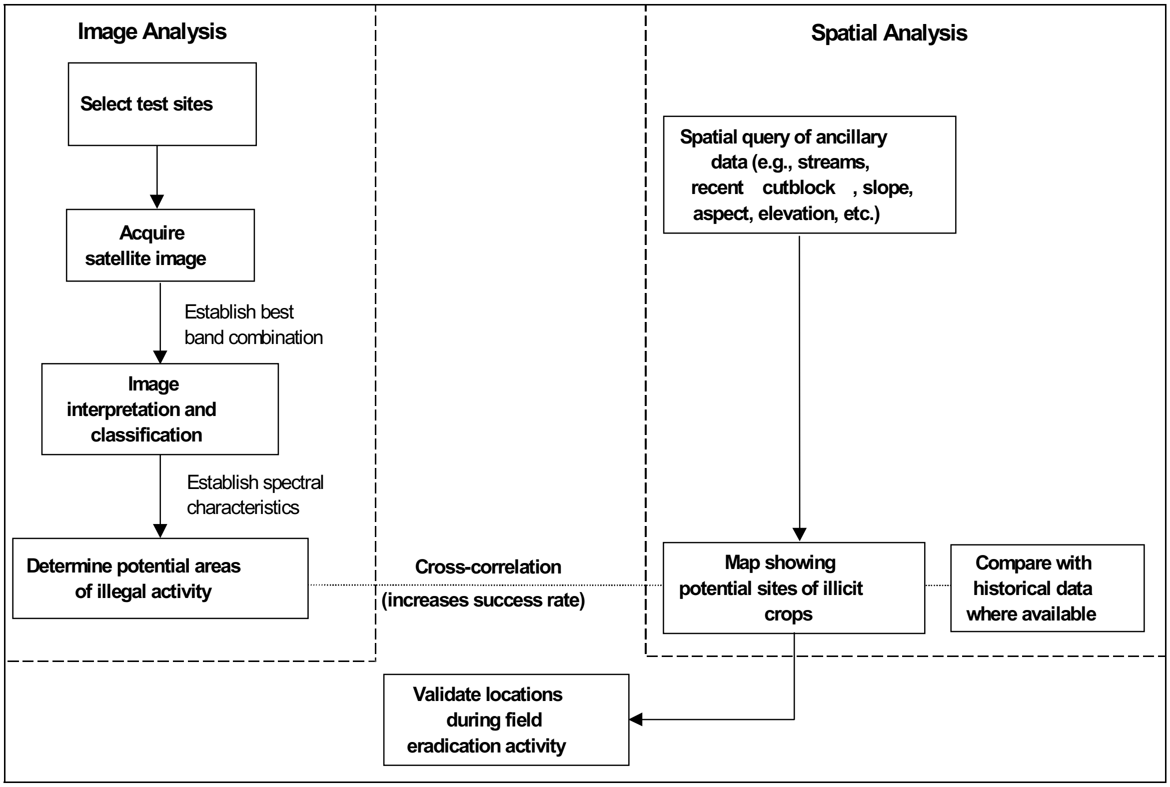

Figure 2 Complementary GIS Analysis and Image Analysis Streams

3.2 Image Processing

Commercially available image processing and GIS software tools (PCI's EASI/PACE and ESRI's ArcView) were employed for the data processing and analysis functions. The imagery was processed in a manner that permitted it to be used for qualitative analysis as well as delineation of suspected illicit crop growth areas. This methodology also allowed the data to be used for production of IKONOS image maps. Each image was imported from its GeoTiff source data into path oriented PCI (16 bit) image databases. Figure 3 presents a flow diagram for this process.

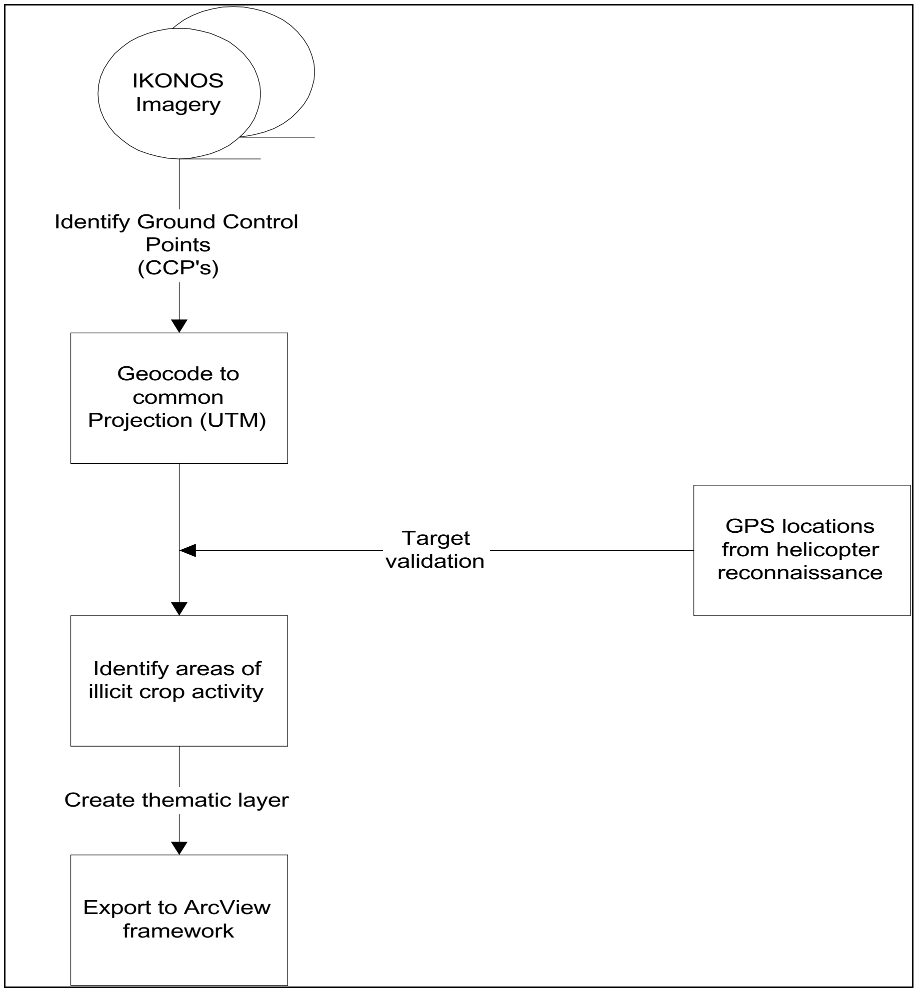

Figure 3 Image Processing Flow

3.3 Field Verification of IKONOS Imagery and Field Data

On Tuesday, August 8th, RSI geomatics technician Karen Bannerman accompanied RCMP Cpl. Tom Howell to Kelowna to perform aerial reconnaissance over the project test areas. They were met by Mr. Terrence Trytten, the RCMP Air Watch Coordinator in Kelowna, who took Tom and Karen up in the helicopter to survey Seymour Arm. On the way up to Seymour Arm some known outdoor grow operations were noted in order to develop an understanding of the characteristics of outdoor grow operations. The plants were deep green in colour, grown in black pots, and dispersed in swampy areas that were fairly accessible by road. (See Appendix I, Figure A1).

A grid search was performed across the IKONOS image area and revealed one small grow of about 50 - 60 plants. Again the plants were in pots, in a swampy area close to a road. The geographic location was noted using the helicopter GPS, and photographs were taken (Appendix I, Figure A2).

In the morning of Thursday, August 10th, Terrence and Karen flew again in the helicopter to view Area 4 (Upper Kettle Valley) with Kelowna pilot Bill Romanica. No outdoor operations were sited although the area had many typical sites for outdoor grows (notably swampy and accessible by road), however the majority of the area was above 4000 feet in elevation and as such not conducive to marihuana growth. (Appendix I, Figure A3 – areas above 4000 feet are shown as blue polygons).

3.4 ArcView GIS Database Development

Forest cover GIS layers (FC1 files) were supplied by the BC Ministry of Forests and used to create the baseline GIS layer for each test area. The FC1 files are multi-layer MicroStation files that correspond to a 1:20 000 map sheet. Each file contains 53 different layers of information. A complete listing of each data layer and code can be found in Appendix II of this report. The following data layers were extracted and used for this project:

- single line water features (5; rivers)
- double line water features (6; rivers and large lakes)
- road systems (8),
- ownership (31; Crown or non-Crown land)

Each layer was registered to a UTM, Zone 11. Normally, the FC1 files also have a code for aspect (29) and elevation (30), however these were not available. Each of the four data layers listed above were imported into the ArcView GIS software and combined to form one layer for each of the four study areas.

The RCMP provided RSI with a digital copy of the Detachment Boundaries for the province of BC as well as files showing the location of legal hemp licenses. These files were digitized and imported into the GIS software for future use.

RSI supplied digital elevation models (DEMs) for the areas of interest. The DEMs were used to provide elevation data and were imported into ArcView. A new data layer was created to display locations suitable for crop growth (elevation under 1219m and a south facing slope).

A precision geocoded LANDSAT-7 multi-spectral 30 metre resolution image was also provided by RSI for general delineation of cut blocks and wetland areas, which were manually digitized into separate layers within ArcView.

One precision geocoded IKONOS multi-spectral 4 metre resolution image was acquired of each of the study areas (Seymour Arm, Slocan Valley, Upper Kettle, and Christina Lake). The 4-metre resolution allowed us to see more detail for further delineation of cut blocks and wetlands, as well as to update some of the logging and access roads that were not located on the FC1 layers. This imagery also provided a visual confirmation of terrain features.

4.0 Results and Discussion

4.1 IKONOS Spectral Analysis

The approach to the image analysis was to locate known grow operations on the ground and then correlate them with the information contained in the imagery for that same location. In remote sensing terms, the image analysis reveals the unique spectral characteristics, or spectral signature, of the geophysical variable of interest, in this case marihuana.

A known grow operation of about 65 plants in Area 1 (Seymour Arm) was used to determine the spectral signature of the plants in the IKONOS imagery. Once a signature is obtained, it can be used to identify other areas within the imagery having the same reflectance characteristics and therefore to identify additional areas of marihuana growth.

The initial hypothesis for the project was that the grow operations would be primarily located in forest clear cuts and would require some irrigation for growth. If this were the case, the marihuana plants would be greener and more moist than the surrounding vegetation, which would be lacking the same degree of irrigation, and would therefore stand out in the imagery.

Unfortunately, the plants in this grow operation were located in a wetland area (Appendix I, Figures A1 and A2) and therefore could not be easily distinguished from the surrounding wetland vegetation, which had a similar colour as the marihuana plants. It was therefore difficult to obtain a signature from the marihuana that was unique from other vegetation. Furthermore, it was difficult to visually identify the grow operation itself from the 4m resolution imagery. Since the rest of the imagery collected was also 4m multi-spectral, we were not successful in identifying a unique spectral signature using the imagery alone.

4.2 IKONOS Image Interpretation

Image interpretation for all images acquired was performed visually following a series of digital image enhancements. Since the four study areas are quite similar in physical nature, the discussion and results presented here pertain to all images, with specific references to an area or image being made as required.

For all images (Appendix I, Figures A4-A7) the road networks can easily be identified as white linear features dissecting the landscape, often leading to forest cut blocks. The forest cut blocks are easily recognized by their lighter shade of green as well as an irregular shape. More recent cut blocks tend to show up as a light brown while those areas having some forest regeneration show greater amounts of green as a function of emerging vegetation.

Forested areas can be recognized by their dark green / black tones as well as by their unique texture, which is related to the forest canopy. Water bodies appear as a dark blue, however, in some cases the effect of sediment loading from rivers can be seen in lakes as light blue (e.g., Appendix I, Figure A5 in the lower right corner of the Seymour Arm image). Wetland areas usually appear as dark tones surrounded by bright green depending in the amount of vegetation present around the margins. Individual marihuana plants could not be distinguished using the 4m imagery.

4.3 GIS Query and Analysis

The final step in the project was to create GIS database queries to help identify *probable* sites. The queries were performed for each area of IKONOS imagery. These queries were based on previous consultation with the RCMP included the following parameters:

- within 50 metres from a water source
- within 500 metres from road access
- within a cutblock or wetland area
- areas under 1200 m (4000 ft) elevation
- areas that are south facing
- areas within Crown land (all the image areas were within Crown land; some were within park land). This parameter is important as it's easier, from a jurisdictional perspective, to bust operations on Crown land than privately owned land.

These data layers were overlaid on each other to create a composite data layer (Appendix I, Figure A8). This composite layer was then queried to identify those areas that met all of the parameters listed above. Those that did were identified as *potential* sites. A schematic diagram of the overlay procedure, along with a sample query, is presented in Figure 4.

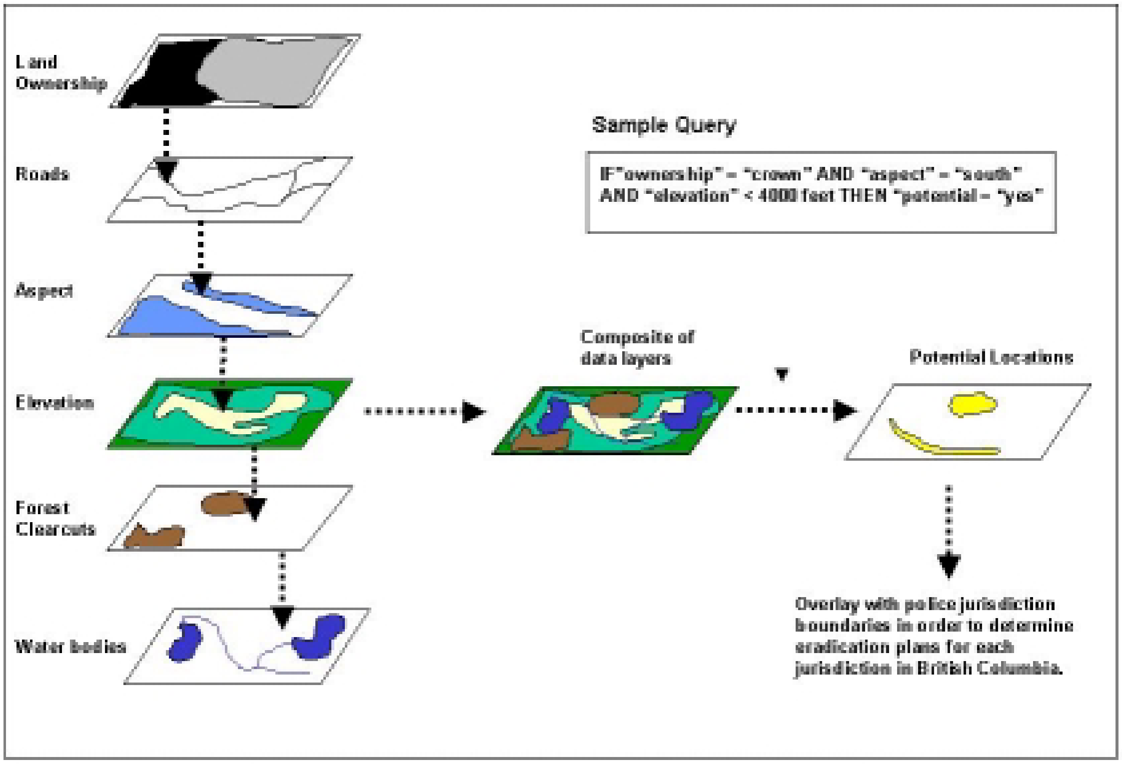

Figure 4 Schematic of overlay procedure using sample query

Ground truth information was readily available for the Seymour Arm site. The resulting query and location of the marijuana grow can be seen in Appendix I, Figure A9.

The results of the queries were converted to ArcView layers and compiled to create digital/hardcopy images.

5.0 Conclusions

5.1 Utility of Remote Sensing and GIS for Monitoring Marihuana Grow Activities

Various methods of disguise and deception will continue to be employed by illegal grow operators. The objective of this pilot project was to present a methodology that would provide a cost effective method of thwarting these measures by locating outdoor grow operations within the province of British Columbia.

The results of the image spectral and interpretation analysis did not prove favourable for the study areas chosen. The main reasons for this are likely a function of the imaging resolution together with the planting methods being employed. Presently, the resolution of the multi-spectral imagery is four metres, however, efforts are underway to analyze an integrated product of the panchromatic (1m resolution) and multi-spectral images that will have a higher overall resolution.

In contrast, results from the GIS were favourable and illustrated that measurable success can be realized simply using the data layers incorporated in the system, a very good first attempt at locating the marihuana could be achieved. Ground verification of an actual grow operation was closely located to the locations predicted by the GIS analysis of spatial overlays. We are therefore confident of the utility of using a GIS to locate potential illicit crop areas.

While eradication and prosecution of outdoor grow operations can best be carried out using traditional methods and approaches, the integrated solution of GIS and, in future, high resolution imagery, will provide an effective non-invasive method of identifying illegal outdoor marihuana grow sites. Due to circumstances beyond the control of those involved in the project, a complete test of the original hypothesis could not be performed. Nonetheless, the GIS component of the project proved to be a sound, if unsung, success.

5.2 Recommendations for the Future

While the results presented here are not conclusive, they have served to provide a methodology for the RCMP to reduce their costs of determining potential locations of illicit crops through the “cold hit” method. By performing simple GIS overlays of the available data layers areas of high probability for illicit crop growth were produced.

Due to time and budgetary constraints, an exhaustive evaluation of this technique could not be performed, but the project did show the utility of this simple technique. Although it is difficult to itemize the cost savings of using this method in an operational environment, it is very likely to reduce the amount of flight time required to locate illicit crops grown in similar operations.

It is also important to note that this initial project identified a number of shortcomings in the initial planning methodology. Careful consideration of these parameters should facilitate a more streamlined system in the future. It is imperative that those working on the project have a complete understanding of, and are in agreement with, the objectives of the project. Also, a good level of understanding of current grow conditions needs to be obtained. Project planning should be at all levels ranging from management to the field agent. This will allow for knowledgeable decision making.

5.3 Future Monitoring Scenario

This pilot project has provided an initial contact between the RCMP and RSI. As a direct result of this interaction a monitoring framework for the future has been identified, as shown in Figure 5.

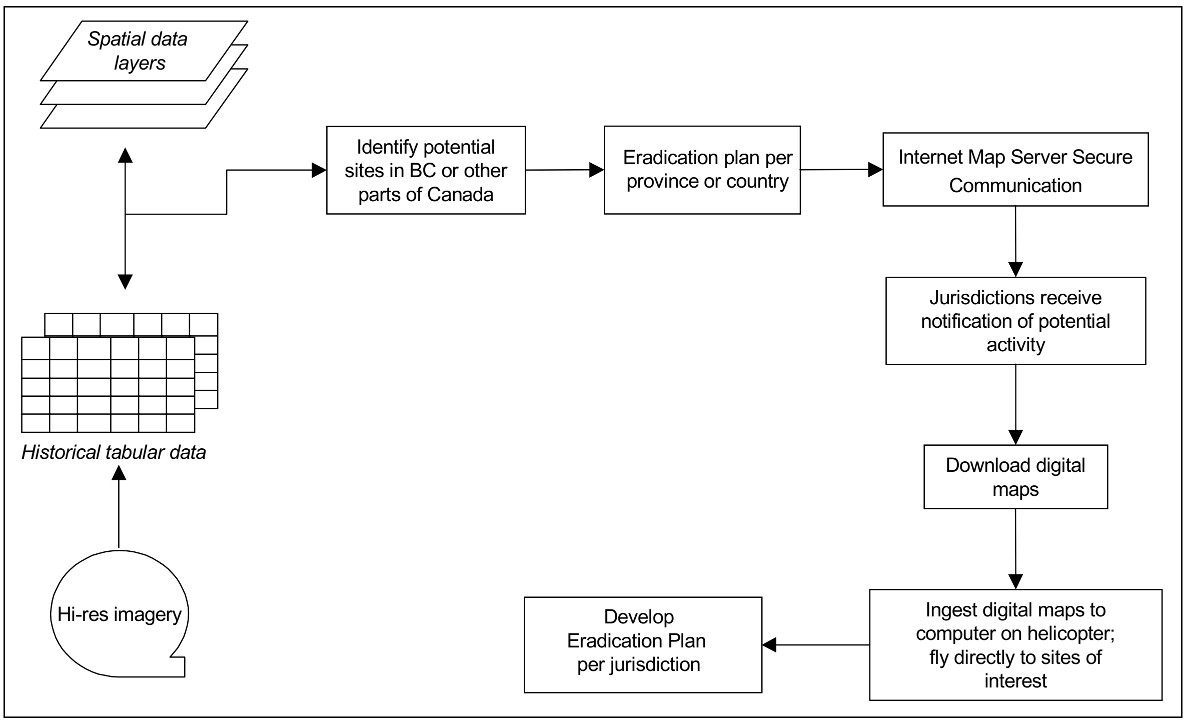

Figure 5 Proposed Monitoring Framework

The GIS data layers can be created for the province or even the entire country and queried to locate potential areas for illicit crop growth. Eradication plans can then be developed based on the areas of greatest potential. Through a secure Internet map server located at provincial headquarters, further map queries can be created. For example, by querying potential grow operation sites within police jurisdictional boundaries, RCMP headquarters in Vancouver could determine which jurisdiction should be responsible for eradication in a certain area, as well as plan the best strategies to eradicate the operations (e.g., from the air or by road). This can all be performed from a desk in a central office location without the need for cold hits.

Digital maps of potential grow sites could then be downloaded to each jurisdiction headquarters and fed directly into a computer on board the helicopter which could then be more efficiently dispatched to locating grow operations. Figure A10 (Appendix I) shows an example of a query by RCMP jurisdictional boundaries in the southern Okanagan valley of BC.

6.0 Benefits Analysis

This section discusses the benefits of employing the technology used in the pilot project in a fully operational environment. Benefits can be broadly drawn between those realized by the police force tasked with eliminating the grow operations and those realized by society in general. The benefits described here are restricted to those attributable to the RCMP. RSI has defined these as:

- The ability to systematically identify drug growing operations province-wide and quantitatively assess the effectiveness of elimination activities;
- More efficient deployment of resources in identifying and eliminating outdoor drug growing operations;
- Having a show-case system to demonstrate to external parties (other police organizations and politicians) the technology in actual use and its effectiveness.

Table 3 illustrates the efficiency ratios which were demonstrated as part of the pilot project. The efficiency ratio is defined as the total area to searched divided by the area resulting from applying the search criteria to identify potential marijuana growing areas.

Table 3 Efficiencies Realized in the Pilot Test Areas

Location	Location Area (km^2)	Potential Marijuana Growing area Identified (km^2)	Number of Potential Marijuana Growing Sites	Efficiency (location area/ potential area)
Seymour Arm	59,533,320	876,647	83	67
Christina	103,233,888	531,708	94	
Slocan	105,990,047	481,506	1	
Kettle Valley	147,710,208	2,961,499	225	

Four areas were involved in the pilot and represented a total land area of over 416 million km^2. By applying search criteria to these areas, 403 potential sites were identified comprising a total area of 4.8 million km^2. Efficiency ratios ranged from 67 to 220 for the test areas, and averaged 133. Using the search technology could result in significant cost savings in personnel time, resources such as helicopter flights and elapsed time required to identify and eradicate crops. The actual efficiencies achieved will of course vary by area but the efficiency ratios seen in the pilot could be expected in an operational environment.

Appendix I—Images and Illustrations

Figure A1 Marihuana plants located in a readily accessible swampy area

Figure A2 Marihuana plants located in wetland area

Figure A3 Upper Kettle Valley – blue polygons are above 4000 feet /1219m

Figure A4 Slocan Valley

Figure A5 Seymour Arm

Figure A6 Upper Kettle Valley

Figure A7 Christina Lake

Figure A8 Composite Data Layer

Please see next page.

Figure A9 Query and location of potential and confirmed marijuana grow sites in Seymour Arm sub-area

Please see next page.

Figure A10 Example of a query by RCMP jurisdictional boundaries in the southern Okanagan valley of BC

Please see next page.

Appendix II—GIS Data Layers and Codes

Data entered into the digital file is assigned a specific level. This separation of information allows the user to select and combine data required for display or summary purposes. The current system has 63 levels available, of which 59 are assigned. All themes except Forest Cover have polygon line work and text nodes combined on the same level.

1. Sub-unit map neatlines MAP No. 1 (not used in current files)
2. Sub-unit map neatlines MAP No. 2 serial number
3. Sub-unit map neatlines MAP No. 3 (not used in current files)
4. Photo centres, wing points, and fight line numbers (moved by SETUPFC1)
5. Single line water features
6. Double line water features
7. Cadastre (lots, townships, park reserves, etc.)
8. Road systems, power and pipelines, railways, ditches, photo centres, wing points, land district and provincial boundaries, municipal boundaries, etc. (see parameter charts)
9. Forest cover polygons (typelines)
10. Forest cover text nodes, labels (from data base)
11. Ministry of Forests boundaries and text (graphic output)
12. Working level - should be deleted after use
13. Agricultural Land Reserve polygons, text nodes and text
14. Inventory samples, air and ground calls, fisheries symbols
15. Range Improvements and Range Title
16. Forest Cover Title, Nodsid Forest Cover Label with text node
17. Base map title and sectional base map not plotted with Forest Cover
18. Range samples, air and ground calls, boundary text, pasture pattern
19. Arrows from labels to polygons, slide symbols and typeline offset (graphic)
20. Common overlay elements other than Forest Cover (work level, delete after use)
21. Soils polygon, text nodes and text
22. Area of Interest - Job Boundary (spare 1)
23. Inventory Region and Compartment polygons, text nodes and text
24. Planning Cell polygons, text nodes and text
25. Biogeoclimatic polygons and text nodes
26. Reserved for future use
27. Timber Supply Area and Block polygons, text nodes and text
28. PSYU polygons, text nodes and text
29. Aspect overlay
30. Elevation overlay
31. Ownership polygons, text nodes and text
32. Operability polygons, text nodes and text
33. Forest Region and District polygons, text nodes and text

34. Provincial Forest polygons, text nodes and text
35. UTM 2000 metre grid polygons and text nodes
36. Slope overlay
37. Contours and annotation (spare 8)
38. Cutting permit overlay text nodes and text
39. Perspective Terrain
40. Inventory TRIM updates
41. High resolution contours (10m) and annotation
42. Inventory water features
43. Range polygons and text nodes
44. Recreation unit (spare 6)
45. Recreation unit (spare 7)
46. Wildlife polygons, text nodes and text
47. Recreation resultants, text nodes and text
48. Water Data (specifications not defined)
49. Old Inventory planimetric detail (NON-TRIM roads)
50. Insects and disease polygons, text nodes and text
51. Recreation trails and other graphics (spare 2)
52. spare 3
53. spare 4
54. Silviculture openings MLSIS & ISIS (spare 5)
55. Spare 9
56. Map Angle annotation and final Resultant Grid Data (not used in current files)
57. Skew map neat lines (7 ½' X 7 ½')
58. Skew Map Geographic Information
59. Plotted Surround Information (BCGS)
60. Plotted Geographic Annotation (BCGS)
61. UTM Tics and Annotation
62. Plotted Neat lines (BCGS)
63. Plotted Geographic Tics (BCGS)

Note: Some levels have been allocated for future data capture and manipulation. Levels denoted as spares have text node number ranges set, but require coordination with Forest Resources Inventory Branch for definition and acceptance of data on these levels.