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**Evaluating digital change detection techniques
for landscape monitoring in a data-poor
tropical island environment**

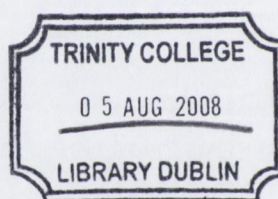
A case study of New Providence Island, The Bahamas

Volume 2 of 2

A thesis submitted to the University of Dublin, Trinity College
in fulfilment of the requirements for the degree of
Doctor of Philosophy

Jean Wilson

May 2008



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8557.2.

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Chapter 2 Tables and Figures

Table 2.1. Sensor descriptions Landsat sensors 1 through 5 and 7.

Landsat series	Sensor	Spectral sensitivity (waveband in μm)	Resolution (m)
1, 2, 3	RBV	0.475-0.575 0.580-0.680 0.690-0.830 0.505-0.750*	80 80 80 30
1,2,3,4,5	MSS	0.5-0.6 0.6-0.7 0.7-0.8 0.8-1.1	79 79 79 79 120
3,4,5, 7	TM & ETM+***	0.45-0.52 0.52-0.60 0.63-0.69 0.76-0.90 1.55-1.75 10.4-12.5 10.4-12.6* 2.08-2.35	30 30 30 30 30 120, 60** 30
7	ETM+	0.52-0.90	15

* included in Landsat 3 only

** Landsat 7 thermal band only

*** Landsat 7 only

Table 2.2. Sensor descriptions SPOT sensors 1-4.

SPOT series	Sensor	Spectral sensitivity (waveband in μm)	Resolution (m)
1, 2, 3	HRV	B1 0.50-0.59 B2 0.61-0.68 B3 0.78-0.89 Pan 0.50-0.73	20 20 20 10
4	HRVIR	B1-B3 B4 1.58-1.75 Pan 0.61-0.68	20 20 10
4,5	VGT	B0 0.43-0.47 B2-B4	1000 1000
5	HRVIR	B1-B3 B4 Pan 0.48-0.71	10 20 2.5 or 5
5	HRS	Pan 0.49-0.69	5 or 10

Chapter 3 Tables and Figures



Figure 3.1. The Islands of The Bahamas.

Table 3.1. A comparison of percent population increase and decrease for each inter-census time period between 1963 and 2000 across four major Bahamian islands.

	1963-1970	1971-1980	1981-1990	1991-2000
New Providence	25.46	33.43	26.66	22.90
Great Exuma	9.51	-2.57	-3.57	0.90
Andros	18.55	-6.08	-1.83	-5.75
Grand Bahama	214.20	28.01	23.97	14.52
Bahamas Total	29.64	24.11	21.74	19.04

Source: Adapted from BEST, 2005

Table 3.2. Terrestrial and marine habitats of The Bahamas identified as part of the proposed Bahamas Ecoregional Planning initiative (Sealey et al., 2002).

	Habitat	Description	Distribution
Terrestrial	Beach strand	Coppice or bush comprising shrubs, herbs and vines occurring along the shoreline with a sand substrate	Throughout
	Dry Evergreen Formation or Coppice	Comprises forests and thickets of evergreen broadleaf tress and herbaceous plants	Throughout
	Pine land (pine rocklands)	Caribbean pine forests and woodlands in rocky areas	Restricted to New Providence, Abaco, Andros and Grand Bahama
	Wetlands	Mangrove communities occurring along the coastal zone of the archipelago including ponds	Throughout
Marine	Coral reef	Fringing, patch, barrier and channel reefs. Elkhorn (<i>Acropora palmata</i>) and staghorn (<i>Acropora cervicornis</i>) are the two most important coral species	Abundant on windward and north eastern sides of the islands
	Seagrass	Turtle grass (<i>Thalassia testudinum</i>), shoal grass (<i>Halodule wrightii</i>) and manatee grass (<i>Syringodium filiforme</i>) grow extensively throughout the waters of The Bahamas predominantly in low-energy environments	Throughout The Bahamas in water ranging from depths of inches to ca 10s of metres

Source: Adapted from Sealey et al., 2002



Figure 3.2. Caribbean pine with DEF understory, within the National Forest Reserve, New Providence Island, The Bahamas.



Figure 3.3. Dense dry evergreen forest formation (coppice), The Bahamas.



Figure 3.4. Coastal coppice formation, The Bahamas.



Figure 3.5. Destruction of native pineland for development on New Providence Island, The Bahamas.



Figure 3.6. Clearance of DEF for tourism development, The Bahamas.



Figure 3.7. Sea wall construction in New Providence Island leading to beach erosion.



Figure 3.8. Inland mangrove community surrounded by DEF, New Providence Island, The Bahamas

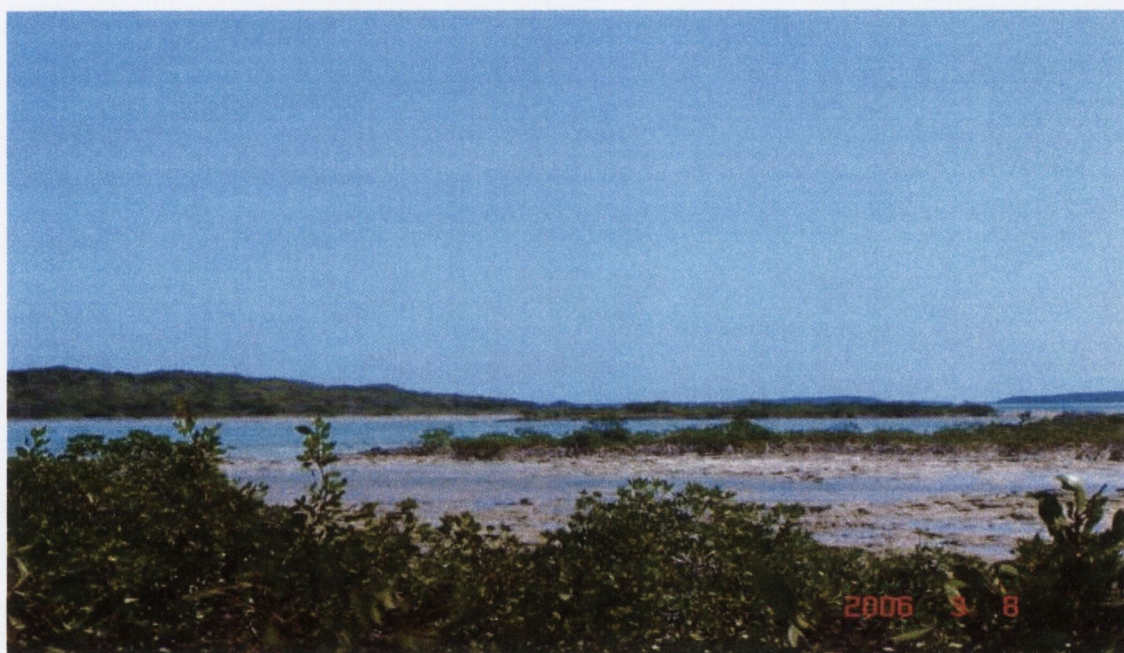
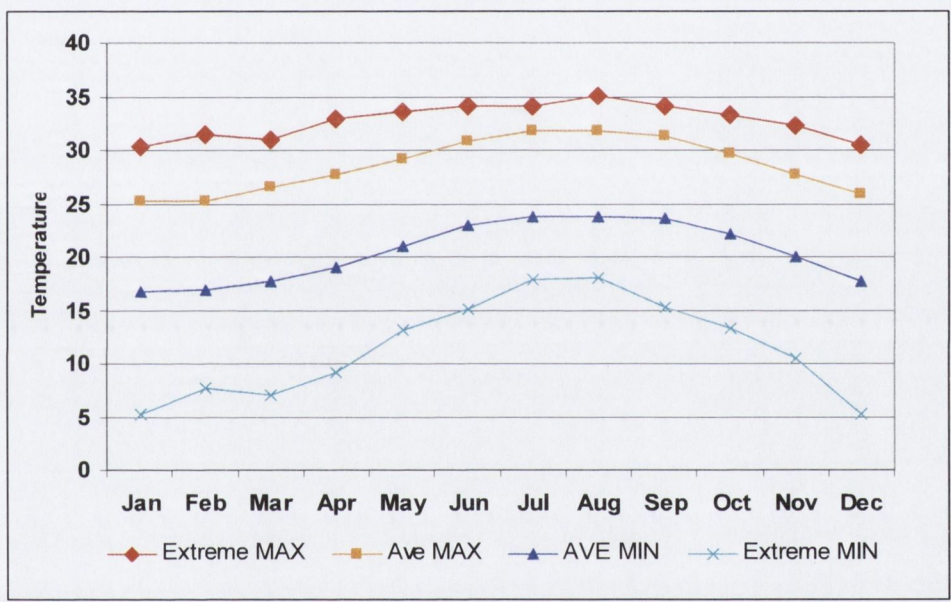


Figure 3.9. Coastal mangrove community surrounded by DEF, New Providence Island, The Bahamas.



Figure 3.10. Dredge and fill of mangroves in operation for development on New Providence Island, The Bahamas.



** Adapted from data compiled by Sealey (1994)*

Figure 3.11 Average and extreme maximum and minimum monthly temperatures for Nassau, New Providence Island, 1961-1990 (°C).

Table 3.3. Number of tropical storms and hurricanes for selected islands between 1971-2000.

	Northern Bahamas		Central Bahamas			Southern Bahamas
	Abaco	Bimini	Grand Bahama	Exuma	New Providence	Inagua
1871-1900	11	10	12	6	8	6
1901-1930	12	6	8	3	5	4
1931-1960	12	9	11	12	9	6
1961-2000	4	6	8	4	2	2
Total	39	31	39	25	24	18

Adapted from BEST, 2005

Table 3.4. Governmental Institutions involved in land management of The Bahamas.

Government Institution
Office of the Prime Minister
Ministry of Health and the Environment
Department of Environmental Health Services
Department of Agriculture
Water and Sewage Corporation
BEST Commission
Ministry of Public Works and Utilities
Department of Physical Planning
The Bahamas National Trust*

**non-governmental
Adapted from Best, 2005*

Chapter 4

Tables and Figures

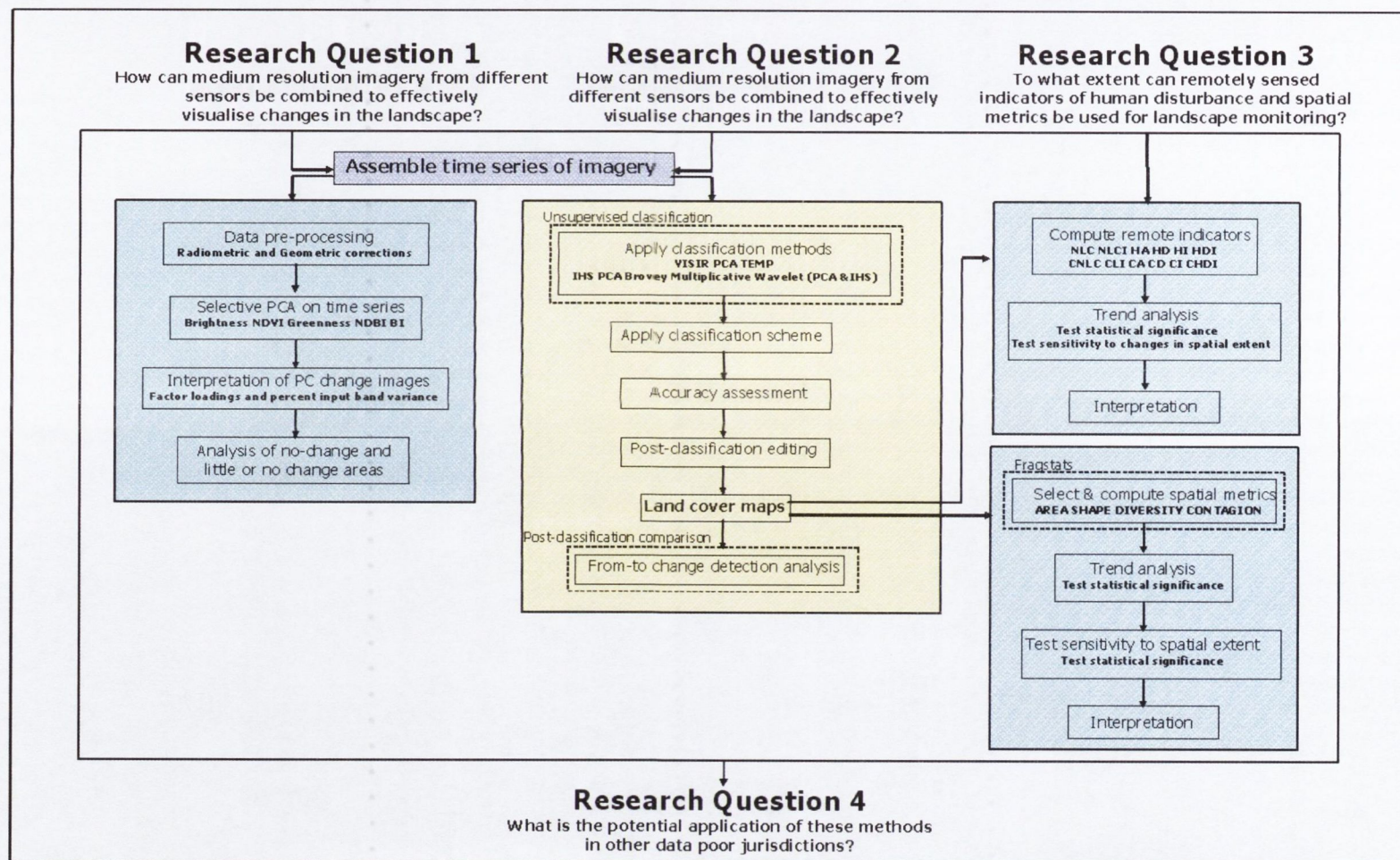


Figure 4.1. A schematic illustration of the methodological processes applied to address the research questions posed in this study.

Table 4.1. List of Landsat MSS, TM and ETM+ satellite imagery of New Providence Island, The Bahamas, downloaded for use from the GLCF.

ID	Sensor	Acquisition date dd/yy/mm	Pixel size (m)	Path/Row
022-729	Landsat 1 MSS	15/12/73	60	014/043
LT5013043008511610	Landsat 5 TM	26/04/85*	30/120	013/043
012-268	Landsat 5 TM	29/04/86**	30/120	013/044
042-582	Landsat 7 ETM+	16/05/01	30/60/15	013/043
042-583	Landsat 7 ETM+	16/03/02	30/60/15	013/043

*additional imagery purchased from the USGS EROS Data Centre <http://edc.usgs.gov>

** unsuitable for use due to cloud cover

Table 4.2. List of SPOT HRV and HRVIR satellite imagery of New Providence Island, The Bahamas, used in the analysis.

Entity ID	Sensor	Acquisition date dd/yy/mm	Pixel size (m)	SPOT Image Grid Reference System (GRS) K / J
16303008604261556312X	SPOT 1 HRV	26/04/86	20	630/300
46293009911151607242I	SPOT 4 HRVIR	15/11/99	20	629/300
46293009911151607242M	SPOT 4 HRVIR	15/11/99	10	629/300

Table 4.3. Chronology of medium resolution satellite data used in the time series analysis of landscape change occurring on New Providence Island, The Bahamas.

Acquisition date (dd/mm/yy)	Sensor	Wavebands	Spectral sensitivity of wavebands (μm)	Spatial Resolution (m)
15/12/73	Landsat 1 MSS	2,3,4	0.6-0.7, 0.7-0.8, 0.8-1.1	60
26/04/85	Landsat 5 TM	2,3,4,5	0.52-0.6, 0.63-0.69, 0.79-0.9, 1.55-1.75	30
26/04/86	SPOT 1 HRV 2	1,2,3	0.5-0.59, 0.61-0.68, 0.78-0.89	20
15/11/99	SPOT 4 HRVIR 2	1,2,3,4	0.5-0.59, 0.61-0.68, 0.78-0.89, 1.58-1.75	20
16/05/01	Landsat 7 +ETM	2,3,4,5	0.52-0.6, 0.63-0.69, 0.79-0.9, 1.55-1.75	30
16/03/02	Landsat 7 ETM+	2,3,4,5	0.52-0.6, 0.63-0.69, 0.79-0.9, 1.55-1.75	30

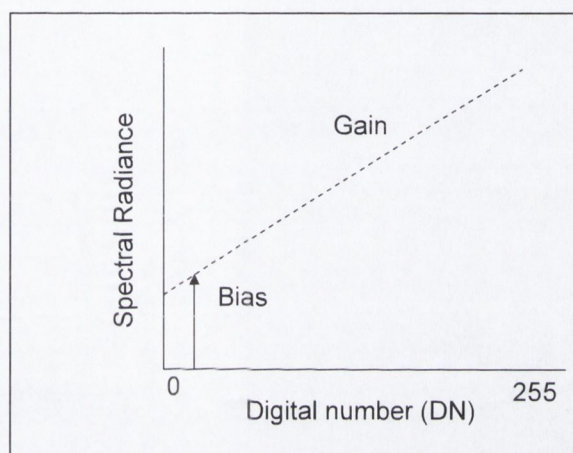


Figure 4.2. The relationship between calibrated DN and spectral radiance as a function of gain and bias.

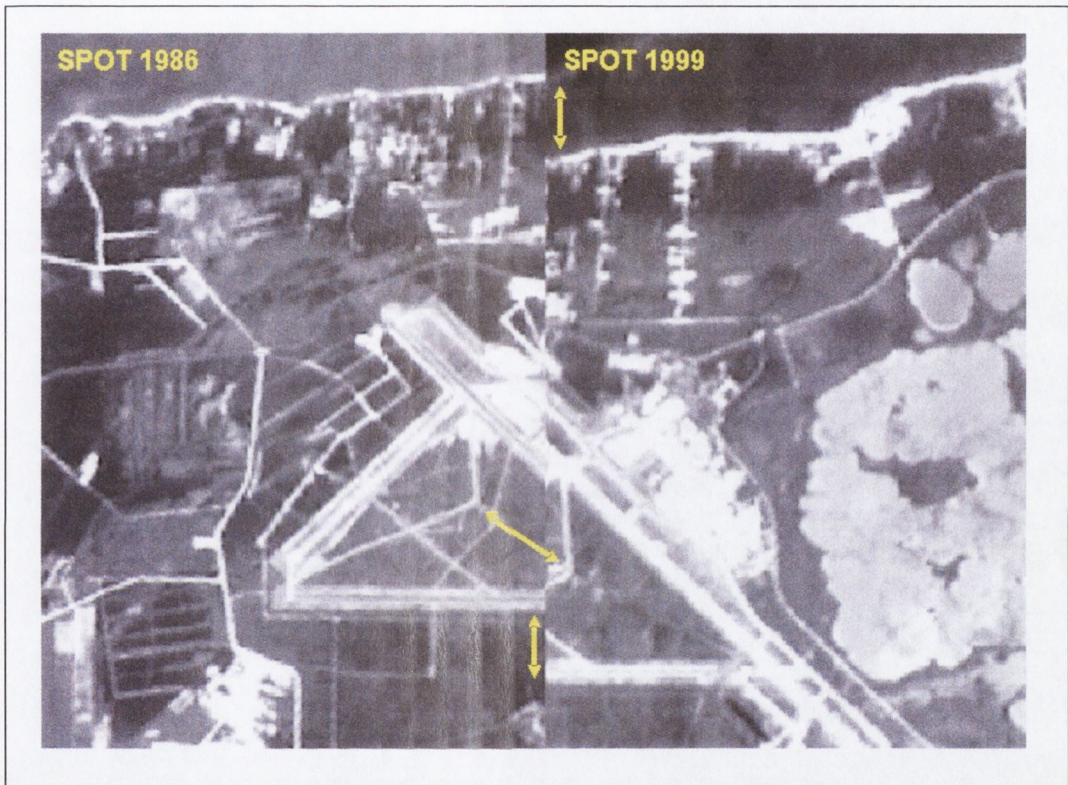


Figure 4.3. Illustration of spatial mismatch between SPOT HRV 1986 and SPOT HRV 1999 imagery.

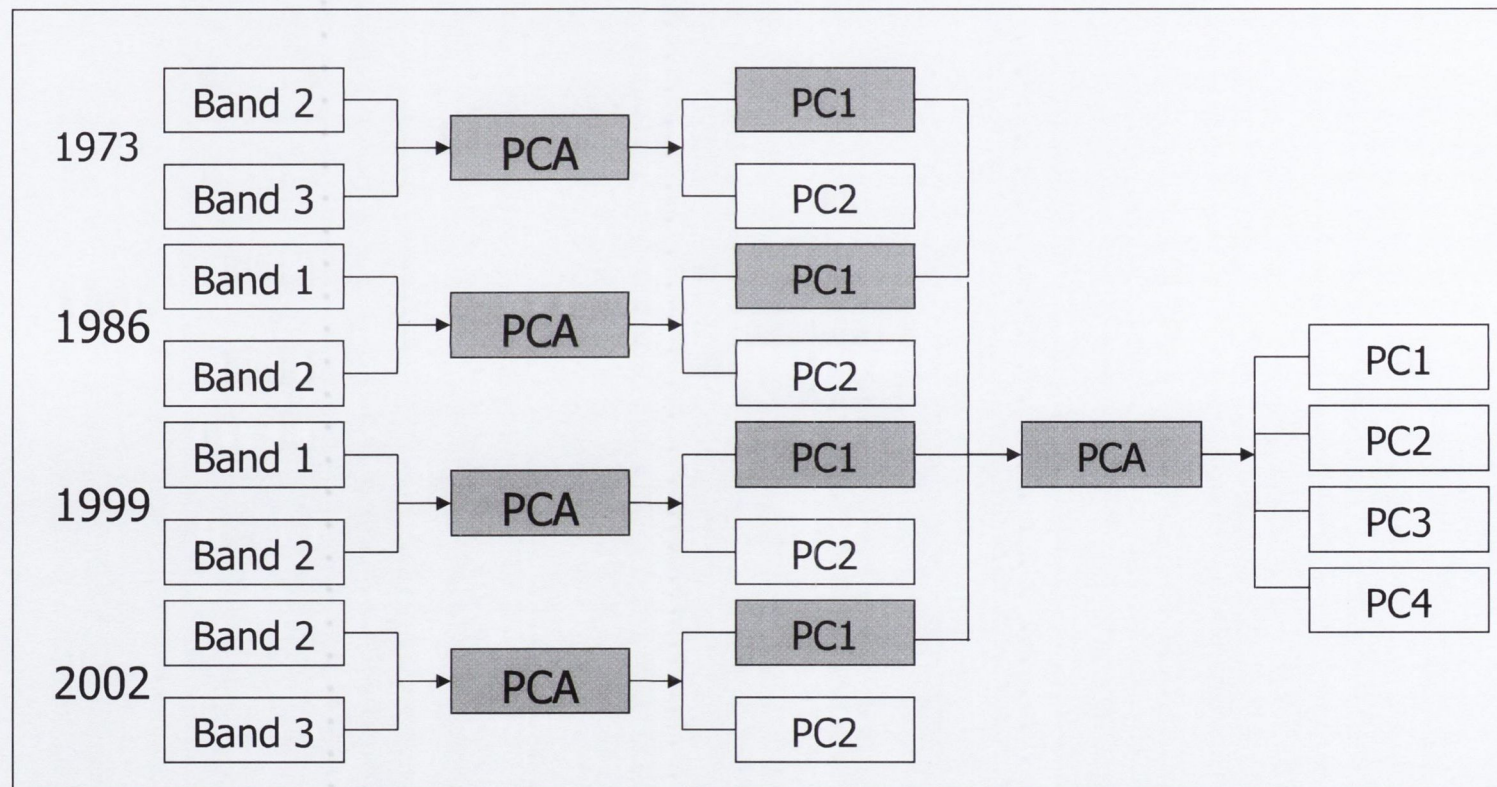


Figure 4.4. Flow diagram of multitemporal selective PCA methodology for derivation of changes in brightness using red and green bands.

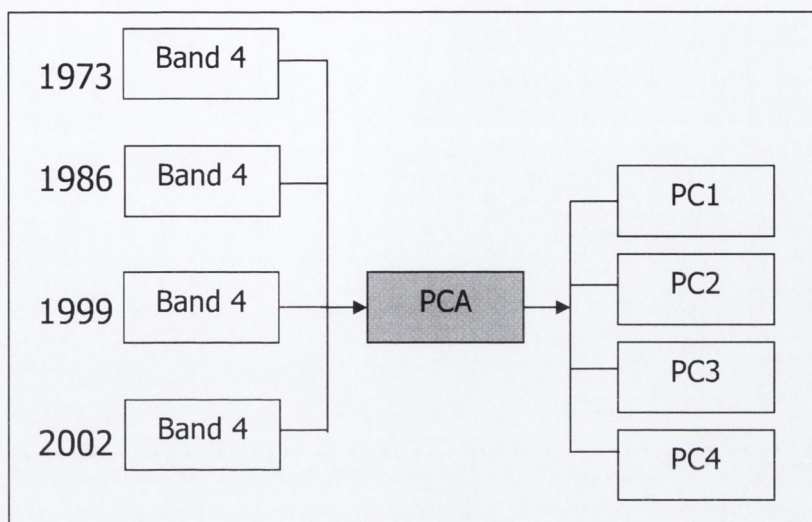


Figure 4.5. Flow diagram of multitemporal selective PCA methodology for derivation of changes in greenness using the NIR band.

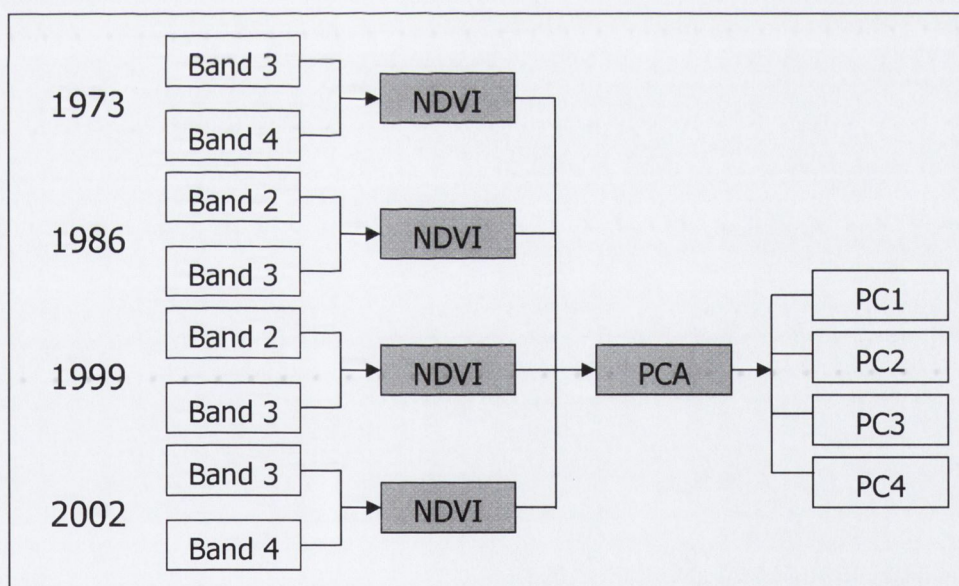


Figure 4.6. Flow diagram of multitemporal selective PCA methodology for derivation of changes in NDVI using red and NIR bands.

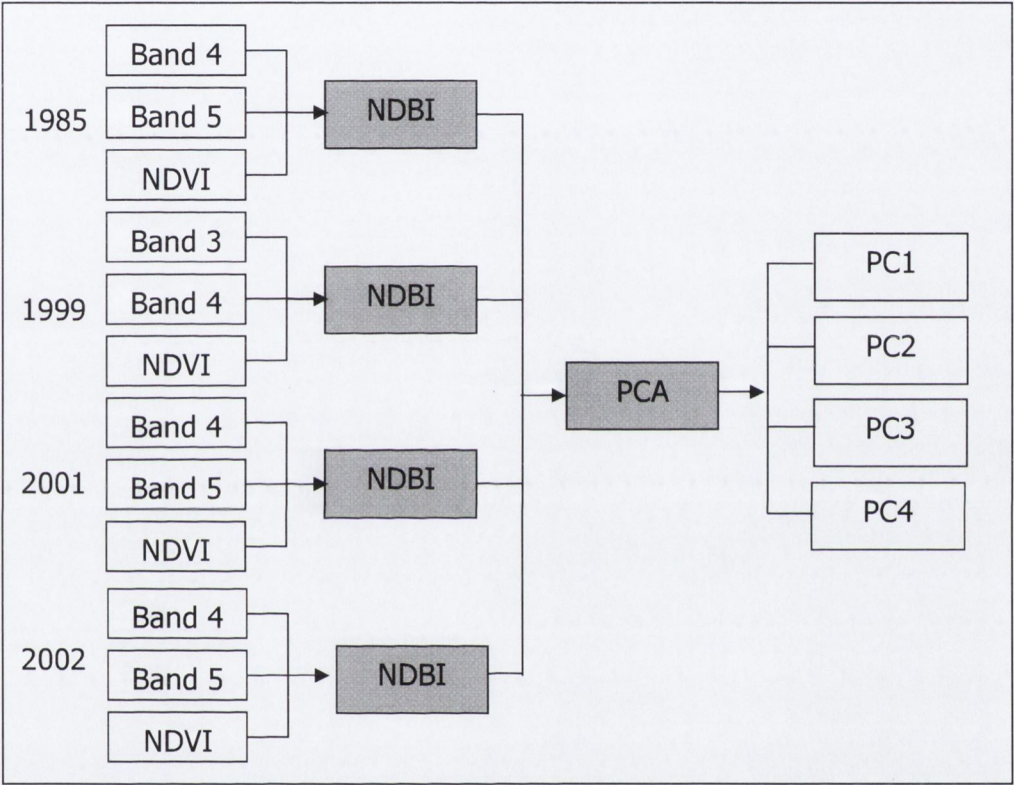


Figure 4.7. Flow diagram of multitemporal selective PCA methodology for derivation of changes in NDBI using NIR, MIR bands and the NDVI.

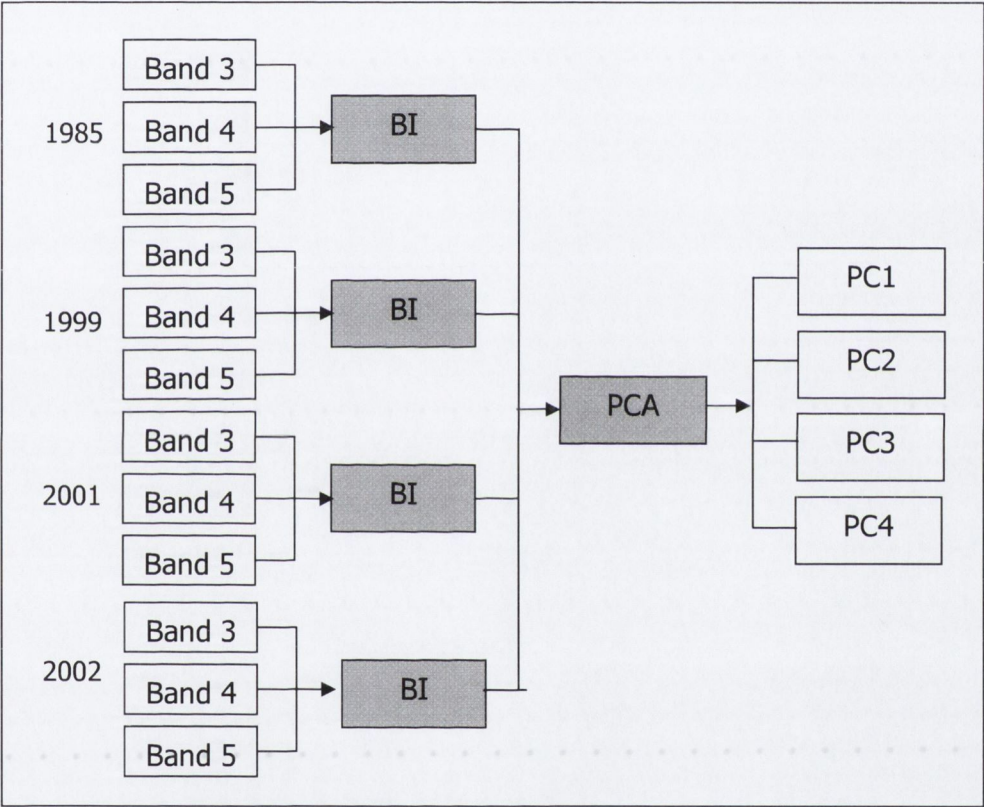


Figure 4.8. Flow diagram of multitemporal selective PCA methodology for derivation of changes in BI using red, NIR and MIR bands.

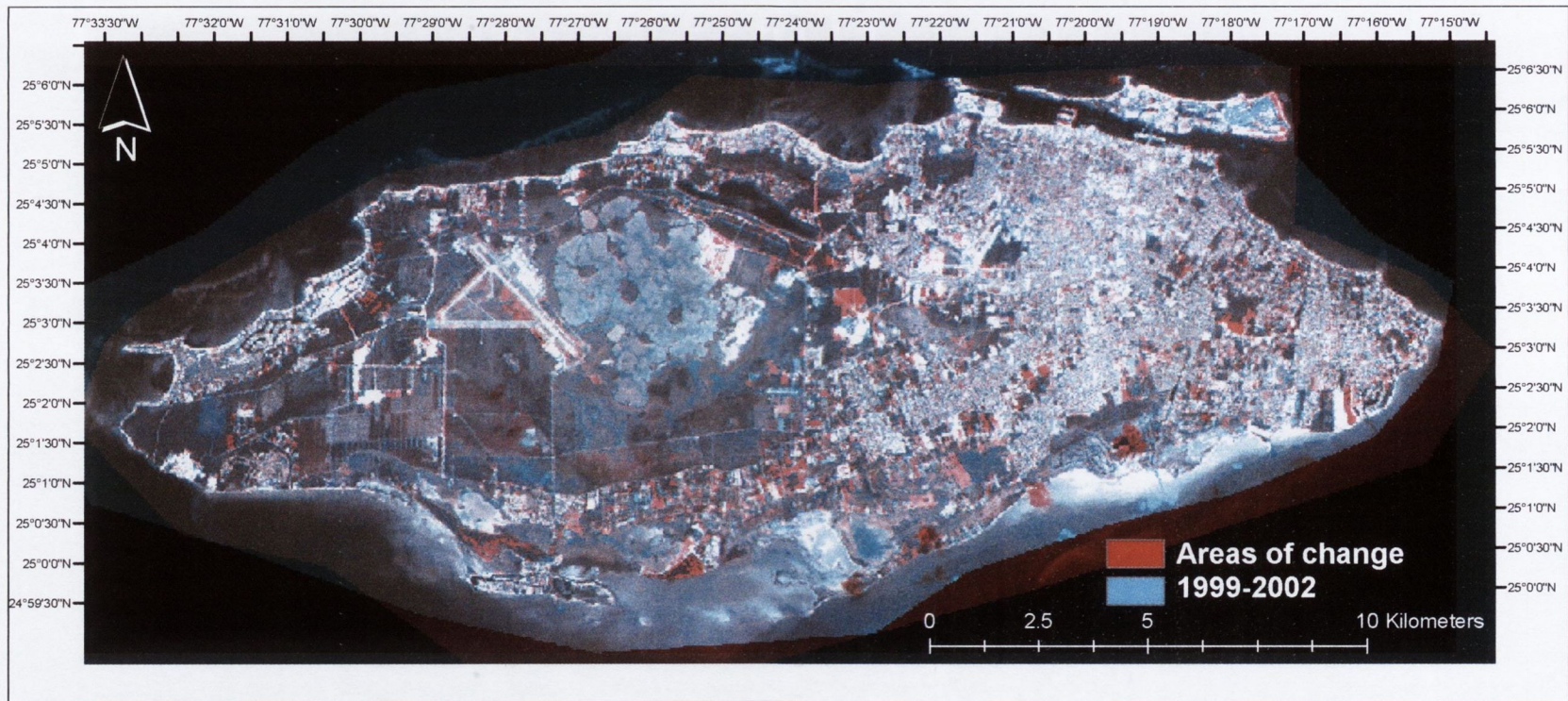


Figure 4.9. WFMI using spectral reflectances from the red band, generated to highlight changes in urban land cover on New Providence Island (The Bahamas) between 1999 (band 2) and 2002 (band 3).

Chapter 5 Tables and Figures

Table 5.1. Suite of image classification methods applied to the time series of medium resolution satellite imagery acquired from five different sensors for the study area.

No.	Code	Pre-classification enhancements	Method description	Sensor Dataset	Map Resolution (m)
1	VISIR	None	Combination of all spectral bands except thermal and panchromatic	MSS TM ETM+ SPOT 1 SPOT 4	57 28.5 28.5 20 20
2	PCA	PCA	First three components derived from a PCA analysis of all spectral bands except thermal and panchromatic	ETM+ SPOT 1 SPOT 4	28.5 20 20
3	Temp	Computation of temperature	Combination of all spectral bands (except panchromatic) and temperature derived from thermal IR waveband	ETM+	28.5
4	TempPCA	Computation of temperature followed by PCA	First three components derived from a PCA analysis of all spectral bands (except panchromatic) and temperature derived from thermal IR waveband	ETM+	28.5
4	IHS PCA Brovey Multi	Data fusion	Combination of all spectral bands data fused using IHS, PCA, Brovey and Multiplicative resolution merge algorithms	ETM+ SPOT4	15 10
5	WaveletIHS WaveletPCA	Data fusion	Combination of Wavelet transformed spectral bands not including thermal	ETM+ SPOT4	15 10

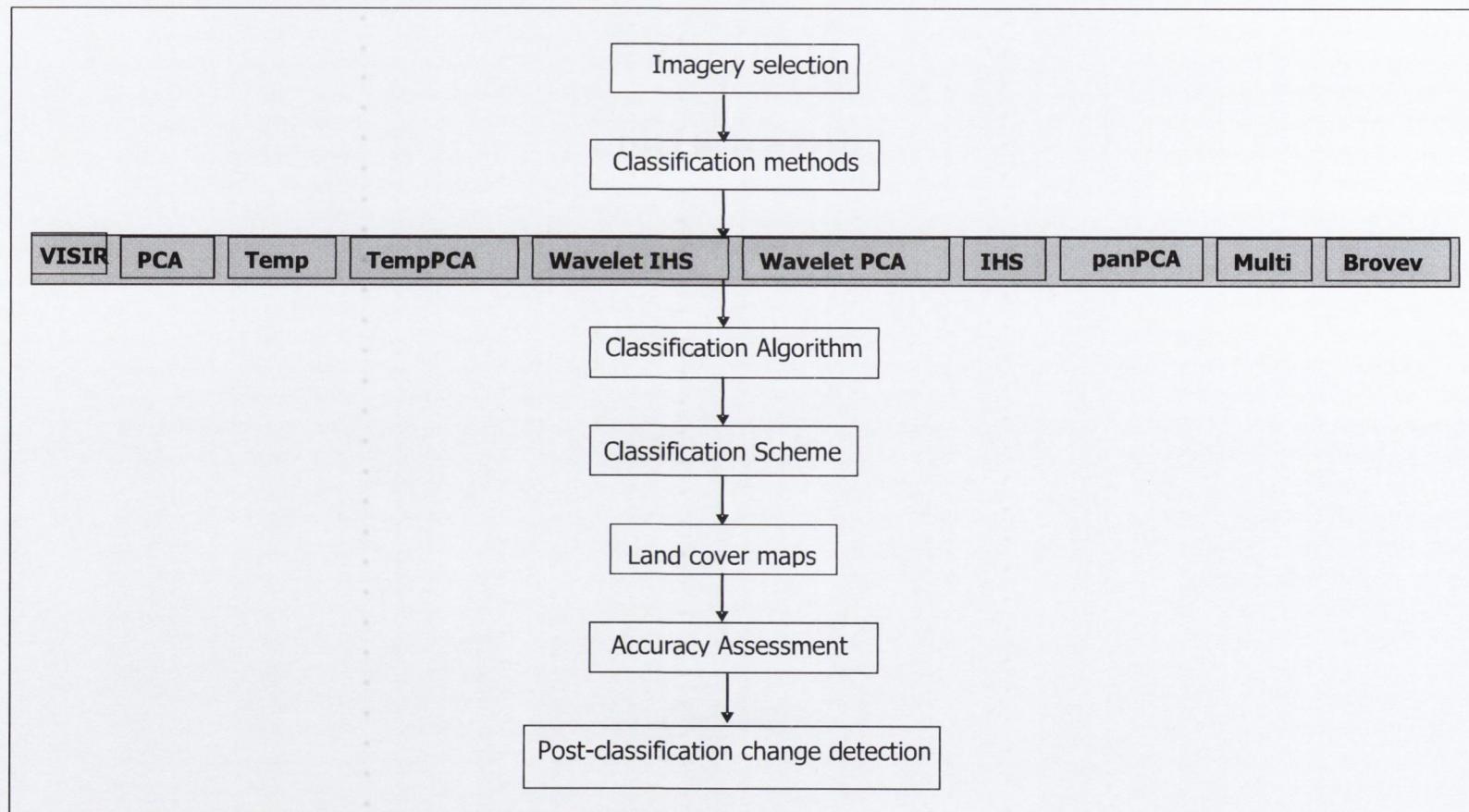


Figure 5.1. Flow chart depicting land cover classification methodology applied to the dataset.

Table 5.2. Terrestrial mapping classes used in the land cover classification modified from the BEP

Land cover Classes	Colour Code	Description
Human Altered Landsacpe (HAL)		Residential/urban/commercial/industrial areas, roads, cleared land and agriculture
Pinelands		Pine rocklands, areas of Caribbean pine
Dry evergreen forest (DEF)		Forests, shrublands, dwarf shrublands and thickets of evergreen broadleaf trees and woody herbs
Dense mangrove		Red, black and white mangrove communities that form coastal wetlands as fringe, over wash basin, hammock or scrub/dwarf mangrove forests
Sparse mangrove		
Sand		Exposed sandy banks and white sand beaches
Water		Inland bodies of fresh and saline water
Cloud and cloud shadow		Areas obscured on the satellite image

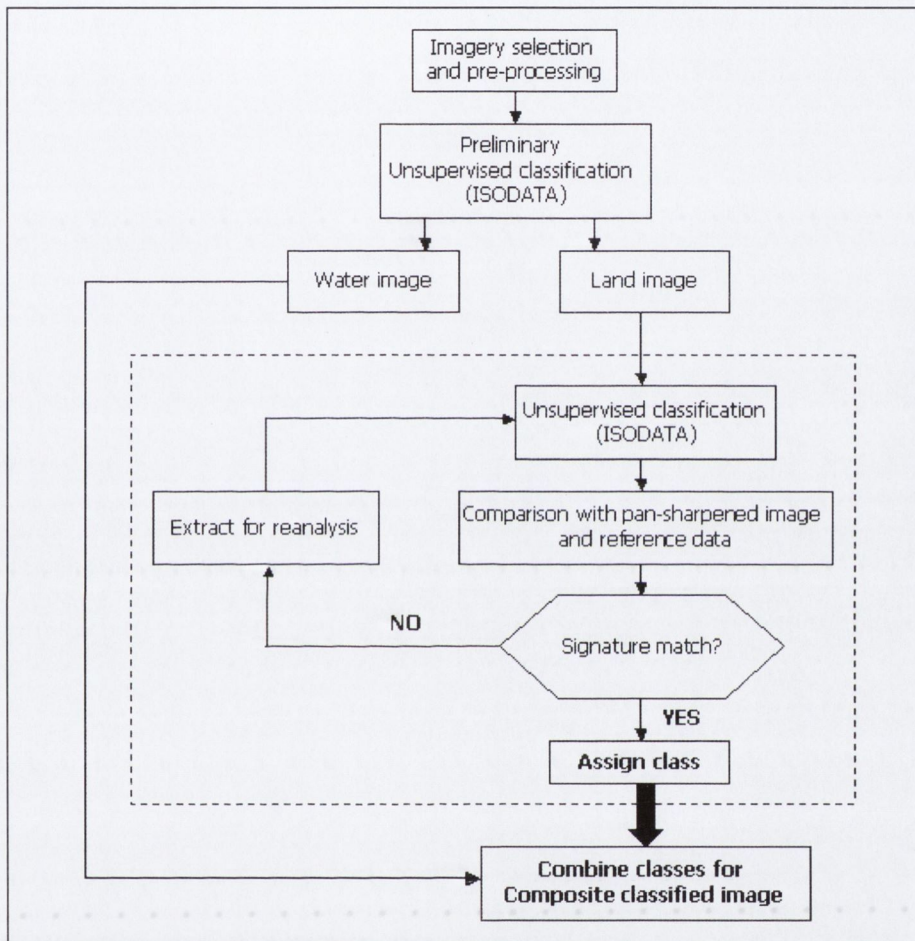


Figure 5.2. Flow chart depicting unsupervised classification procedure applied to the imagery.



Figure 5.3. Gathering ground reference test information in the field, New Providence Island, The Bahamas, March 2006.

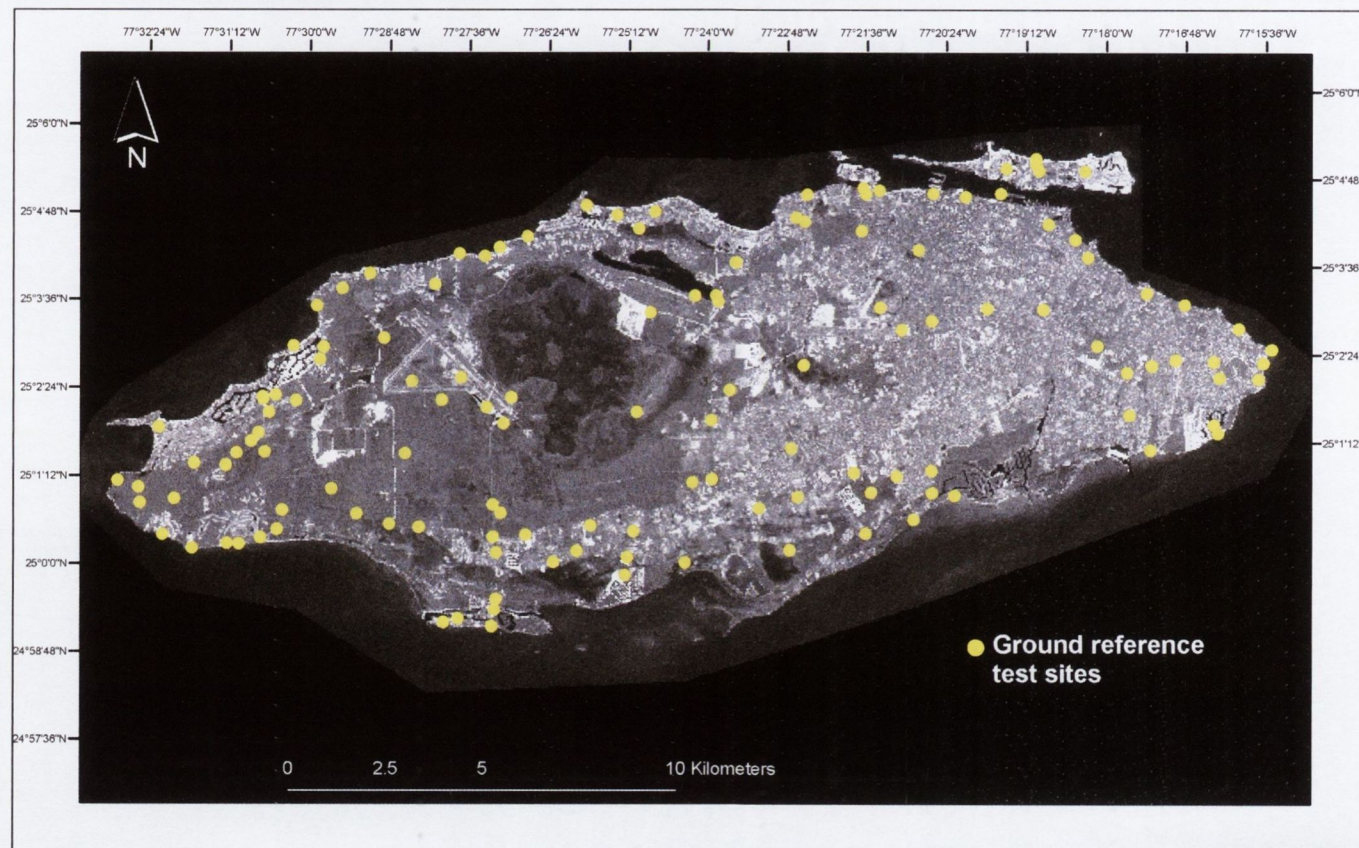


Figure 5.4. Spatial distribution of ground reference test information gathered across New Providence Island (The Bahamas) overlaid on a panchromatic image of the study area acquired in 2002.

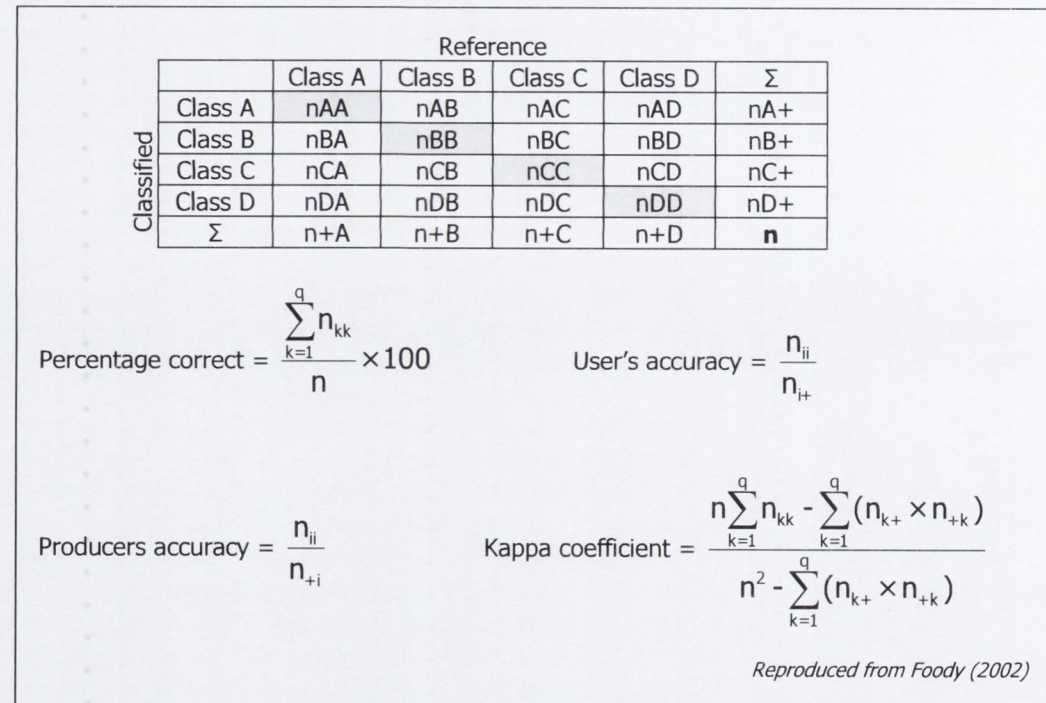


Figure 5.5. An example of an error or confusion matrix and measures of classification accuracy generated from it.

Table 5.3. Interpreting the Kappa coefficient of agreement between reference and classified land cover data based on Landis and Koch (1977).

Kappa Value	Measure of Agreement
<0	Less than chance agreement
0.01-0.2	Slight agreement
0.21-0.40	Fair agreement
0.41-0.60	Moderate agreement
0.61-0.80	Substantial agreement
0.81-0.99	Almost perfect agreement
1.00	Perfect agreement

Chapter 6

Tables and Figures

Table 6.1. Remotely sensed indices of natural landscape extent and disturbance contributing to the overall index of human disturbance (overall index of coastal disturbance) generated for the entire island (500m and 200m area of coastal zone).

Index	Acronym	Description	Computation
Natural Landscape Cover	NLC	Proportion of the island represented by natural landscape (i.e. DEF, pine, sand-dune and mangrove areas) serving as important areas for wildlife habitat and coastal protection	<u>Total area of natural landscape</u> Total land cover area
Natural Landscape Integrity	NLI	Compares the current extent of natural landscape to the estimated historic extent	<u>Total area of natural landscape</u> Historic natural landscape area
Wetland Integrity	WI	Compares the current extent of mangrove communities to the estimated historic extent	<u>Total wetland area</u> Historic wetland area
Vegetation Integrity	VI	Compares the current extent of vegetation (DEF and pine) to the estimated historic extent	<u>Total vegetation area</u> Historic vegetation area
Human Alteration	HA	Proportion of island represented by human altered landscape	<u>Total HAL area</u> Total landscape area
Human Disturbance	HD	Ratio of HAL to natural landscape area	<u>Total HAL area</u> Total area of natural landscape
Human Impact	HI	Compares the current extent of human altered landscape to the estimated historic extent	<u>Total HAL area</u> Historic area of HAL
Coastal Natural Landscape	CNLC	Proportion natural landscape (including sand) within the coastal zone	<u>Total area of coastal natural landscape</u> Total area of coastal zone
Coastal Landscape Integrity	CLI	Compares the current proportion of natural landscape within the coastal zone to the estimated historic extent	<u>Total coastal natural landscape area</u> Historic coastal natural landscape area
Coastal Human Alteration	CA	Proportion of coastal zone represented by HAL	<u>Total coastal HAL area</u> Total area of coastal zone
Coastal Human Disturbance	CD	Ratio of HAL to natural landscape area within the coastal zone	<u>Total coastal HAL area</u> Total area of coastal natural landscape
Coastal Human Impact	CHI	Compares the current extent of human altered landscape within the coastal zone to the estimated historic extent	<u>Total coastal HAL area</u> Historic area of coastal HAL

Table 6.2. Suite of AREA landscape level spatial metrics used in the analysis.

Landscape composition	Metric Acronym	Description	Measure	Range
	TA	Total land area	Total area of the landscape in hectares	$TA \geq 0$ without limit
	NP	Number of patches	Total number of patches in the landscape	$NP \geq 1$ without limit
	PD	Patch density	Number of patches per 100 hectares divided by total landscape area	$PD \geq 0$
	LSI	Landscape shape index	Total edge length in the landscape given in number of cell surfaces divided by minimum total length of edge possible also given in number of cell surfaces	$LSI \geq 1$ without limit LSI is 1 when landscape comprises a single patch LSI increases without limit as landscape shape becomes more irregular or length of edge in a landscape increases
	TE	Total edge	IS the sum of the lengths of all edge segments in the landscape	$T \geq 0$ without limit
	ED	Edge density	Sum of the lengths of all edge segments in the landscape divided by total landscape area in hectares	$ED \geq 0$ without limit
	LPI	Largest patch index	Is the area of the largest patch divided by the total landscape area multiplied by 100 to form a percentage	$0 \leq LPI \leq 100$ percent LPI approaches 0 when the largest patch in the landscape is increasingly small. A simple measure of dominance it quantifies the percent of total landscape area comprised by the largest patch
	AREA_MN	Mean patch area	Distribution of patch area and extent are measured by mean area (area_mn) and area weighted mean (area_am) and characterise the distribution of area among patches	$AREA_MN \geq 1$ without limit
	AREA_AM	Area weighted mean		$AREA_AM \geq 1$ without limit
	AREA_SD	Standard deviation	Standard deviation of patch area measures the variability in patch size	$AREA_SD \geq 1$ without limit
	AREA_CV	Coefficient of variation	Standard deviation of patch area divided by the mean patch area multiplied by 100 to convert to a percentage and can be used to compare variability among landscapes	$0 \leq AREA_CV \leq 100$ percent
	GYRATE_MN	Mean radius of gyration	Gyrate is the mean distance between each cell in the patch and the patch centroid and measures patch extent or connectivity	$Gyrate \geq 0$ without limit
	GYRATE_AM	Standard deviation of gyration		

Table 6.3. Suite of SHAPE landscape level spatial metrics used in the analysis.

	Metric Acronym	Description	Measure	Range
Landscape configuration	SHAPE_MN	Mean shape	Measures mean shape in terms of the relationship between perimeter and area, compares complexity of patch shape to a standard shape of the same size.	SHAPE_MN $\geq$ 1 without limit increases as patch shape becomes more irregular
	SHAPE_AM	Area weighted mean shape		SHAPE_AM $>$ 1 without limit increases as patch shape becomes more irregular
	CONTIG_MN	Mean contiguity	Assesses spatial connectedness or contiguity of cells to provide an index of patch boundary configuration and thus patch shape. Large contiguous patches have large values of contiguity	$0 \leq \text{CONTIG_MN} \leq 1$
	CONTIG_AM	Area weighted mean contiguity		$0 \leq \text{CONTIG_AM} \leq 1$
	PAFRAC	Perimeter-area fractal dimension	A fractal dimension greater than 1 for a 2-dimensional landscape mosaic indicates a departure from a Euclidean geometry (i.e., an increase in patch shape complexity). PAFRAC approaches 1 for shapes with very simple perimeters such as squares, and approaches 2 for shapes with highly convoluted, plane-filling perimeter	$1 \leq \text{PAFRAC} \leq 2$

Table 6.4. Suite of CONTAGION landscape level spatial metrics used in the analysis.

Landscape configuration	Metric Acronym	Description	Measure	Range
	CONTAG	Contagion	Is the probability of finding two randomly chosen cells belonging to patch type i and j and summarises overall clumpiness or compactness. Is a measure of the observed contagion over the maximum possible contagion for the given number of patch types. A patch can be long and convoluted and still have a high value for contagion because the value is based on cell adjacencies	$0 < \text{CONTAG} \leq 100$ percent Measures both interspersions and dispersion. It approaches 0 when the patch types are maximally disaggregated i. e. every cell is a different patch type; and interspersed i.e. equal proportions of all pair-wise adjacencies
	PLADJ	Percentage of like adjacencies	Measures the proportion of cell adjacencies involving the same class multiplied by 100 to convert to a percentage. It measures the degree of aggregation of patch type and a landscape with larger patches with simple shapes will contain a higher percentage of like adjacencies than a landscape with smaller patches and more complex shapes.	$0 < \text{PLADJ} \leq 100$ percent Is 0 when patch types are maximally aggregated i.e. every cell is a different patch type and there are no like adjacencies
	IJI	Interspersion and Juxtaposition	Is a measure of the observed interspersions over the maximum possible interspersions of the given number of patch types multiplied by 100 to convert to a percentage. It is based on patch and not cell adjacencies and does not provide a measure of class aggregation but instead isolates the interspersions or intermixing of patch types	$0 \leq \text{IJI} \leq 100$ percent IJI approaches 0 when the distribution of adjacencies among unique patch types becomes increasingly uneven. IJI = 100 when all patch types are equally adjacent to all other patch types (i.e., maximum interspersions and juxtaposition).
	DIVISION	Division	Is a measure of subdivision and is 1 minus the sum of patch area divided by total landscape area squared, summed across all patches in the landscape. It is based on cumulative patch area distribution and is interpreted as the probability that two randomly chosen pixels in the landscape are not situated in the same patch.	$0 \leq \text{DIVISION} \leq 100$ proportion
	MESH	Effective Mesh Size	MESH is based on the cumulative patch area distribution and is interpreted as the size of the patches when the landscape is divided into S patches where S is the value of the splitting index	$\text{cell size} \leq \text{MESH} \leq \text{total landscape area (A)}$ MESH gives the area-weighted mean patch size, but the proportional area of each patch is based on the total landscape area <i>including</i> any background.
	SPLIT	Splitting index	<i>Split</i> is based on the cumulative patch area distribution and is interpreted as the effective mesh number, or number of patches with a constant patch size when the landscape is subdivided into S patches, where S is the value of the splitting index	$1 \leq \text{SPLIT} \leq \text{number of cells in the landscape squared}$ $\text{SPLIT} = 1$ when the landscape consists of single patch. SPLIT increases as the landscape is increasingly subdivided into smaller patches and achieves its maximum value when the landscape is maximally subdivided; that is, when every cell is a separate patch
	AI	Aggregation Index	AI is calculated from an adjacency matrix, which shows the frequency with which different pairs of patch types (including like adjacencies between the same patch type) appear side-by-side on the map AI equals the number of like adjacencies involving the corresponding class, divided by the maximum possible number of like adjacencies involving the corresponding class, which is achieved when the class is maximally clumped into a single, compact patch, multiplied the proportion of the landscape comprised of the corresponding class, summed over all classes and multiplied by 100 (to convert to a percentage).	$0 \leq \text{AI} \leq 100$ AI increases as the landscape is increasingly aggregated and equals 100 when the landscape consists of a single patch

Table 6.5. Suite of DIVERSITY landscape level spatial metrics used in the analysis.

Landscape composition	Metric Acronym	Description	Measure	Range
	SHDI	Shannon's Diversity Index	A measure of richness (number of patch types) and evenness (the distribution of area among patch types). Is more sensitive to the occurrence of rare patch types	SHDI ≥ 0 , without limit and increases as the no. of different patch types increases or the proportional distribution of area among patch types becomes more equitable
	SIDI	Simpson's Diversity Index	Is 1 minus the sum of the proportional abundance of each patch type squared. Represents the probability that any two pixels selected at random would be different patch types. Less sensitive to the occurrence of rare patch types	$0 \leq SIDI < 1$
	MSIDI	Modified Simpson's Diversity Index	Is 1 minus the log of the sum of the proportional abundance of each patch type squared. This eliminates the intuitive interpretation of Simpson's Index as a probability and is the observed Simpson's Diversity Index divided by the maximum Simpson's Diversity Index for that number of patch types.	$0 \leq MSIDI < 1$
	SHEI	Shannon's Evenness Index	Measures the distribution of area among patch types, an even distribution of area among patch types results in maximum evenness and as such is the complement of dominance. It is calculated as the observed Shannon's Diversity Index divided by the maximum Shannon's Diversity Index for that number of patch types	$0 \leq SHEI \leq 1$ Larger values of evenness imply greater diversity
	SIEI	Simpson's Evenness Index	Measures the distribution of area among patch types, an even distribution of area among patch types results in maximum evenness and as such is the complement of dominance. It is calculated as the observed Simpson's Diversity Index divided by the maximum Simpson's Diversity Index for that number of patch types	$0 \leq SIEI \leq 1$ Larger values of evenness imply greater diversity
	MSIEI	Modified Simpson's Evenness Index	Measures the distribution of area among patch types, larger values of evenness imply greater landscape diversity In other words, the observed modified Simpson's Diversity index divided by the maximum modified Simpson's Diversity index for that number of patch types.	$0 \leq MSIEI \leq 1$

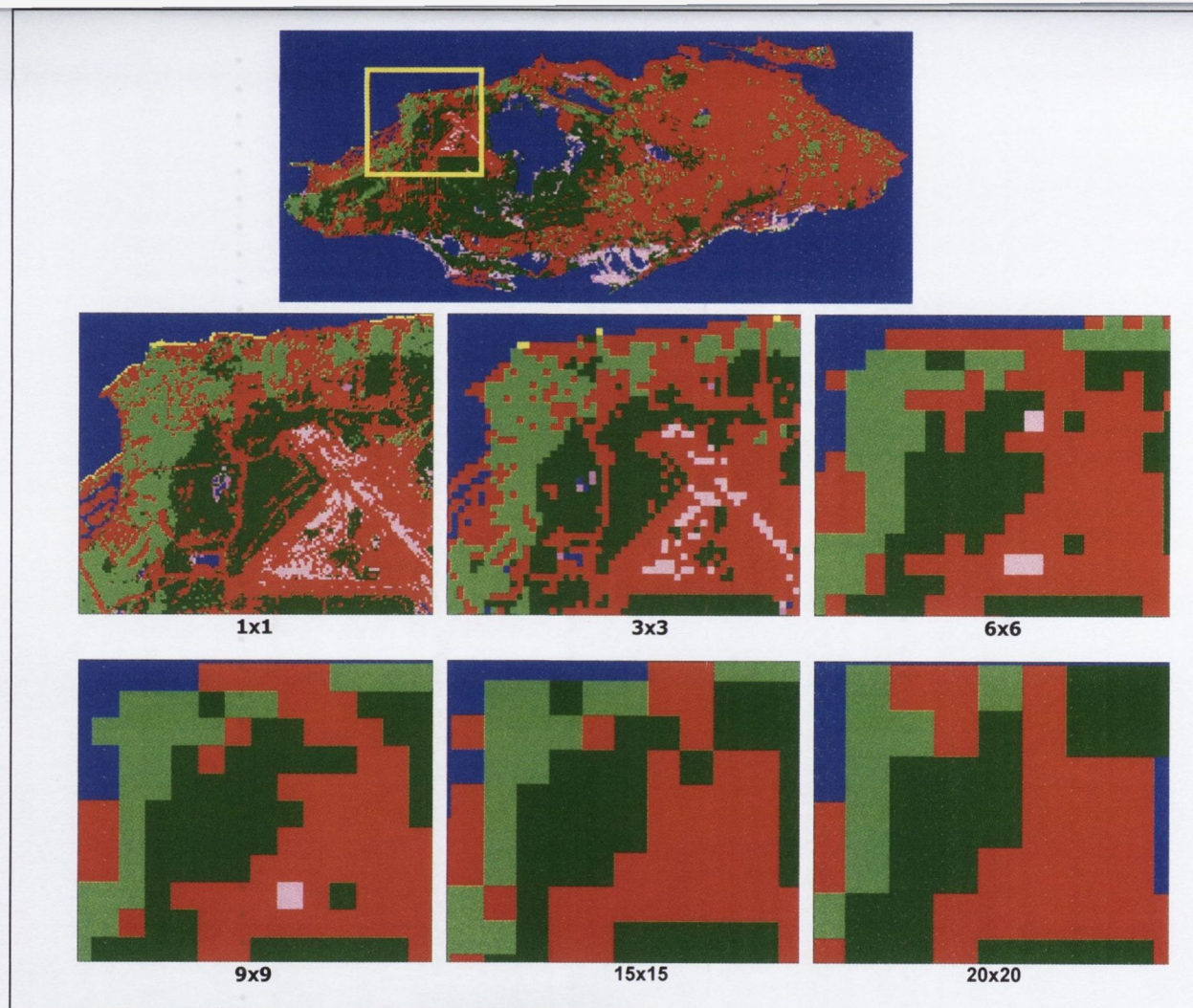


Figure 6.1. Subsets of a land cover map of New Providence (2001) to illustrate the different grain sizes or spatial resolutions generated from the original 1x1 pixel map (30m x 30m) to 20 x 20 (600m x 600m) pixels.

Chapter 7 Tables and Figures

Table 7.1. Spectral gain and bias radiance values ($\text{W m}^{-2} \text{sr}^{-1} \mu\text{m}^{-1}$) used in the conversion of Landsat MSS sensor image DN values to radiance.

Band	Landsat MSS	
	Gain	Bias
1	0.9725490	0.00
2	0.7843137	0.00
3	0.6901961	0.00
4	0.5228745	0.00

Table 7.2. Spectral gain and bias (LMIN) radiances values ($\text{W m}^{-2} \text{sr}^{-1} \mu\text{m}^{-1}$) used in the conversion of Landsat TM and ETM+ sensor image DN values to radiance.

Band	Landsat TM		Landsat ETM+	
	Bias (LMIN)	Gain	Bias (LMIN)	Gain
1	-1.52	0.602431	-6.2	0.775686
2	-2.84	1.175100	-6.4	0.795686
3	-1.17	0.805765	-5.0	0.619216
4	-1.51	0.814549	-5.1	0.637255
5	-0.37	0.108078	-1.0	0.125725
7	-0.15	0.056980	-0.35	0.043725
6*	1.2378	0.055158	3.2	0.037059

* thermal waveband

Table 7.3. Spectral gain and bias radiance values ($\text{W m}^{-2} \text{sr}^{-1} \mu\text{m}^{-1}$) used in the conversion of SPOT HRV and HRVIR sensor image DN values to radiance.

Band	SPOT sensor			
	HRV		HRVIR	
	Gain	Bias	Gain	Bias
1	0.93885	0.00	3.48665	0.00
2	1.05623	0.00	4.39204	0.00
3	1.10638	0.00	4.71456	0.00
4	-		28.55324	0.00

Table 7.4. DN to radiance conversion values applied to Landsat MSS image wavebands.

Band	Conversion
1	0.9725490 x DN
2	0.7843137 x DN
3	0.6901961 x DN
4	0.5228745 x DN

Table 7.5. DN to radiance conversion values applied to Landsat TM and ETM+ image wavebands.

Band	Landsat Sensor	
	TM	ETM+
1	0.602431 x DN – 1.52	0.775686 x DN – 6.2
2	1.1751 x DN – 2.84	0.795686 x DN – 6.4
3	0.805765 x DN – 1.17	0.619216 x DN – 5.0
4	0.814549 x DN – 1.51	0.637255 x DN – 5.1
5	0.108078 x DN – 0.37	0.125725 x DN – 1.0
7	0.056980 x DN – 0.15	0.043725 x DN – 0.35
6*	0.055158 x DN + 1.2378	0.037059 x DN + 3.2

*thermal waveband

Table 7.6. DN to radiance conversion values applied to SPOT HRV and HRVIR and ETM+ image wavebands.

Band	SPOT sensor	
	HRV	HRVIR
1	0.93885 / DN	3.48665 / DN
2	1.05623 / DN	4.39204 / DN
3	1.10638 / DN	4.71456 / DN
4	-	28.55324 / DN

Table 7.7. Solar exoatmospheric spectral irradiances (ESUN_λ in W m⁻² sr⁻¹ μm⁻¹) for Landsat and SPOT imagery used to compute reflectance values.

Band	Satellite Platform				
	Landsat			SPOT	
	MSS	TM	ETM+	HRV	HRVIR
1	1852.0	1957.00	1969.00	1845	1851
2	1584.0	1826.00	1840.00	1575	1586
3	1276.0	1554.00	1551.00	1040	1054
4	904	1036.00	1044.00		240
5		215.00	225.70		
7		80.67	82.07		

Table 7.8. Landsat MSS, TM, ETM+ and SPOT HRV and HRVIR image radiance to reflectance parameters.

Acquisition date	Sensor	Sun Elevation Angle	Solar zenith θ_z degrees	COS θ_z degrees	Julian Day (JD)	d^2
15 Dec 1973	Landsat 1 MSS	34.91	55.09	0.5723	349	1.0322
26 April 1985	Landsat 5 TM	59.72	30.28	0.8636	116	0.9884
29 April 1986	Landsat 5 TM	59.66	30.34	0.8630	119	0.9869
16 May 2001	Landsat 7 ETM+	66.41	23.59	0.9164	136	0.9788
16 March 2002	Landsat 7 ETM+	52.16	37.84	0.7897	85	1.006
26 April 1986	SPOT 1 HRV 2	69.7	20.3	0.9379	116	0.9884
15 Nov 1999	SPOT 4 HRVIR 2	45.3	44.7	0.7108	319	1.0221

Table 7.9. Histogram of minimum DN values acquired from the Landsat and SPOT image datasets.

Acquisition date	Sensor	Waveband number					
		1	2	3	4	5	7
15 Dec 1973	Landsat 1 MSS	14	3	1	1		
26 April 1985	Landsat 5 TM	83	23	20	11	4	1
29 April 1986	Landsat 5 TM	95	29	21	2	1	1
16 May 2001	Landsat 7 ETM+	1	1	1	1	1	1
16 March 2002	Landsat 7 ETM+	37	19	1	1	1	1
26 April 1986	SPOT 1 HRV 2	31	16	7	-	-	-
15 Nov 1999	SPOT 4 HRVIR 2	75	21	1	1	-	-

Table 7.10. Histogram minimum DN value with >1000 pixel count by waveband and corresponding Radiance values (L_{sat_min}) in $W\ m^{-2}\ sr^{-1}\ \mu m^{-1}$ required to calculate path radiance (L_p).

Acquisition date	Sensor	1	L_{sat_min}	2	L_{sat_min}	3	L_{sat_min}	4	L_{sat_min}	5	L_{sat_min}	7	L_{sat_min}
15 Dec 1973	Landsat 1 MSS	16	15.56	6	4.71	2	1.38	2	1.05				
26 Apr 1985	Landsat 5 TM	91	53.30	34	37.11	22	16.56	13	9.08	7	0.39	3	0.028
16 May 2001	Landsat 7 ETM+	76	52.75	56	38.16	32	14.81	12	2.55	11	0.38	9	0.04
16 March 2002	Landsat 7 ETM+	64	43.44	45	29.41	25	10.48	9	0.64	9	0.13	7	-0.04
26 April 1986	SPOT 1 HRV 2	42	44.74	25	23.67	13	11.75						
15 Nov 1999	SPOT 4 HRVIR 2	78	22.37	39	8.88	14	2.97	7	0.25				

Table 7.11 X and Y residuals and RMSE values (metres) for 13 GCP's used to geometrically correct the SPOT HRV 1986 and SPOT HRVIR 1999 imagery.

GCP No.	SPOT HRV 1986			SPOT HRVIR 1999		
	X residual	Y residual	RMSE	X residual	Y residual	RMSE
1	-3.71	-1.42	3.98	-3.78	-0.42	3.81
2	-1.22	-4.98	5.12	6.78	-6.29	9.24
3	4.72	2.86	5.52	-3.13	2.86	4.24
4	-0.32	3.70	3.72	-2.63	7.84	8.27
5	0.49	3.71	3.74	1.85	4.24	4.62
6	3.69	2.18	4.29	3.09	0.86	3.21
7	6.42	2.16	6.77	2.83	-7.76	8.26
8	-2.91	0.28	2.92	-7.12	2.02	7.40
9	-3.79	-2.35	4.46	-8.78	9.01	12.58
10	-8.76	2.90	9.23	8.77	-9.20	12.71
11	8.09	0.79	8.12	7.08	-0.41	7.09
12	6.50	-6.40	9.12	-4.95	-2.74	5.66
13	-9.19	-3.43	9.81	0.00	0.00	0.00
Overall	5.44	3.27	6.35	5.39	5.31	7.56

Table 7.12. Intra-temporal correlation of similar spectral bands, NDVI, NDBI and BI for all input years; a) 1973 b) 1985 c) 1986 d) 1999 e) 2001 and f) 2002.

a)

Landsat MSS 1973			
	Green	Red	NIR
Red	0.75		
NIR	0.65	0.98	
NDVI	0.44	0.75	0.80

b)

Landsat TM 1985						
	Green	Red	NIR	MIR	NDVI	NDBI
Red	0.945					
NIR	0.672	0.785				
MIR	0.609	0.757	0.922			
NDVI	0.297	0.402	0.773	0.716		
NDBI	0.076	-0.006	-0.383	-0.272	-0.714	
BI	0.483	0.517	0.333	0.427	-0.026	0.634

c)

SPOT HRV 1986			
	Green	Red	NIR
Red	0.92		
NIR	0.55	0.71	
NDVI	0.14	0.24	0.81

d)

SPOT HRVIR 1999						
	Green	Red	NIR	MIR	NDVI	NDBI
Red	0.862					
NIR	0.457	0.667				
MIR	0.485	0.714	0.960			
NDVI	0.337	0.462	0.915	0.848		
NDBI	0.195	-0.060	-0.728	-0.596	-0.770	
BI	0.559	0.566	-0.157	0.044	-0.339	0.702

e)

Landsat ETM+ 2001						
	Green	Red	NIR	MIR	NDVI	NDBI
Red	0.929					
NIR	0.636	0.757				
MIR	0.621	0.773	0.916			
NDVI	0.143	0.196	0.569	0.474		
NDBI	0.589	0.431	-0.117	0.112	-0.328	
BI	0.790	0.906	0.694	0.869	0.183	0.515

f)

Landsat ETM+ 2002						
	Green	Red	NIR	MIR	NDVI	NDBI
Red	0.904					
NIR	0.601	0.752				
MIR	0.616	0.801	0.929			
NDVI	0.190	0.264	0.716	0.599		
NDBI	0.571	0.387	-0.191	0.017	-0.431	
BI	0.785	0.925	0.685	0.859	0.228	0.450

Table 7.13. Inter-temporal correlation of similar spectral bands; a) green b) red c) NIR d) MIR; and univariate surfaces e) NDVI f) NDBI and g) BI.

a)

Green					
	1973	1985	1986	1999	2001
1985	0.631				
1986	0.572	0.792			
1999	0.609	0.729	0.760		
2001	0.607	0.838	0.733	0.735	
2002	0.608	0.832	0.724	0.735	0.955

b)

Red					
	1973	1985	1986	1999	2001
1985	0.683				
1986	0.582	0.827			
1999	0.717	0.771	0.755		
2001	0.659	0.776	0.730	0.836	
2002	0.691	0.747	0.693	0.819	0.914

c)

NIR					
	1973	1985	1986	1999	2001
1985	0.928				
1986	0.927	0.943			
1999	0.960	0.929	0.931		
2001	0.919	0.924	0.920	0.937	
2002	0.932	0.923	0.924	0.952	0.966

d)

MIR			
	1985	1999	2001
1999	0.889		
2001	0.865	0.912	
2002	0.860	0.923	0.948

e)

NDVI					
	1973	1985	1986	1999	2001
1985	0.730				
1986	0.730	0.928			
1999	0.710	0.878	0.897		
2001	0.632	0.824	0.830	0.833	
2002	0.588	0.760	0.769	0.761	0.790

Table 7.13. contd..

f)

NDBI			
	1985	1999	2001
1999	0.663		
2001	0.560	0.542	
2002	0.562	0.610	0.846

g)

BI			
	1985	1999	2001
1999	0.444		
2001	0.525	0.421	
2002	0.484	0.399	0.877

Table 7.14 Image combinations used to create a multisensor time-series of imagery in an evaluation of the success of five methods of multitemporal PCA to visualise landscape changes associated with human disturbance.

Methods of multitemporal PCA evaluated	Time series tested	Satellite image sensors
Brightness Greenness NDVI	1973-1986-1999--2002	Landsat MSS SPOT HRV SPOT HRVIR Landsat ETM+
	1985-1999-2001-2002	Landsat TM SPOT HRVIR Landsat ETM+
NDBI BI	1985-1999-2001-2002	Landsat TM SPOT HRVIR Landsat ETM+

Table 7.15. Percent of total input band variance explained by principal components produced by multitemporal PCA (1973-1986-1999-2002).

Multitemporal PCA method	Principal Component number			
	1	2	3	4
Brightness	78.3	9.1	7.3	5.3
Greenness	96.0	2.1	1.3	0.6
NDVI	80.1	11.9	6.0	2.0

Table 7.16. Percent contribution by each input year to the brightness PC images.

Year	PC1	PC2	PC3	PC4
1973	12.21	35.54	42.91	9.35
1986	22.65	49.50	2.26	25.59
1999	27.13	2.86	6.18	63.82
2002	38.01	12.11	48.65	1.24

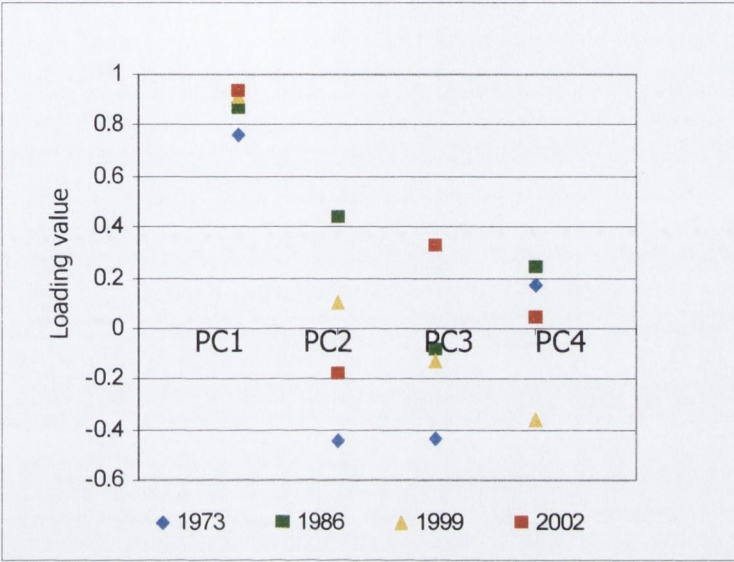


Figure 7.1. Degree of correlation (factor loading values) between input years and brightness PC images.

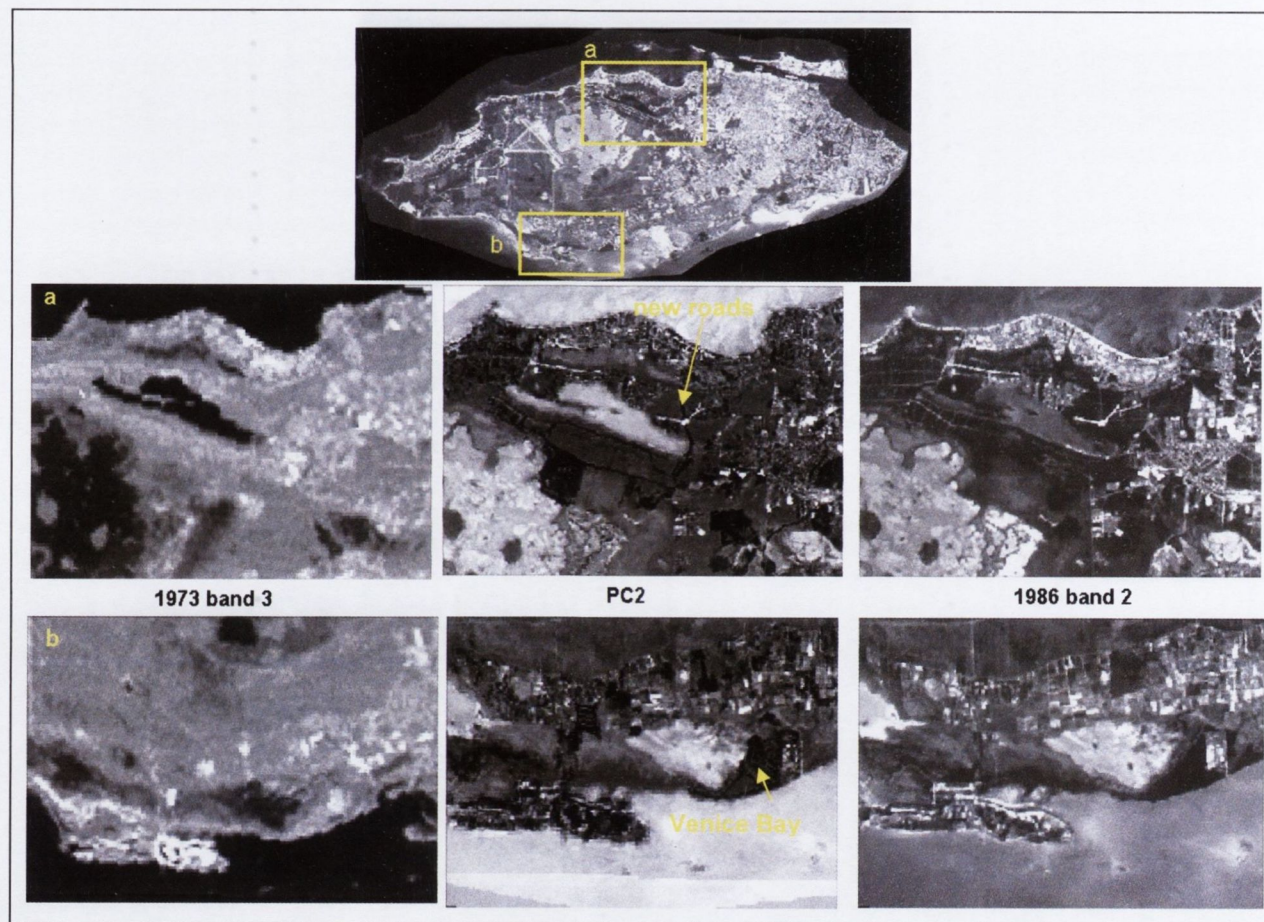


Figure 7.2. A comparison of spectral signatures from Landsat MSS 1973 and SPOT HRVIR 1986 band 2 imagery and PC2 generated from a multitemporal PCA of the brightness time series 1973-1986-1999-2002.

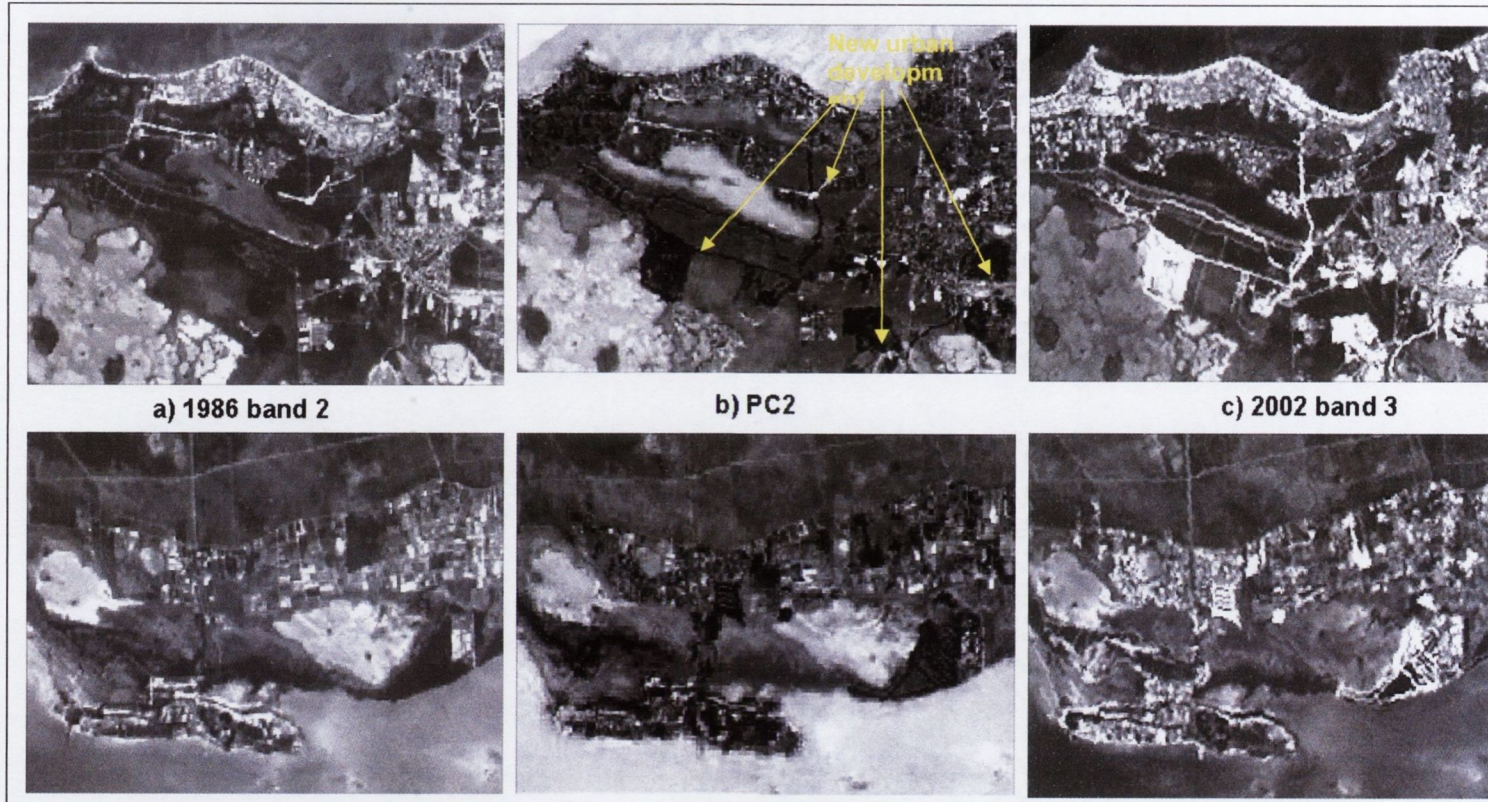


Figure 7.3. A comparison of spectral signatures from a) SPOT HRV 1986 band 2 b) PC2 generated from a multitemporal PCA of the brightness time series 1973-1986-1999-2002 and c) Landsat ETM+ 2002 band 3 for two subsets of the study area.

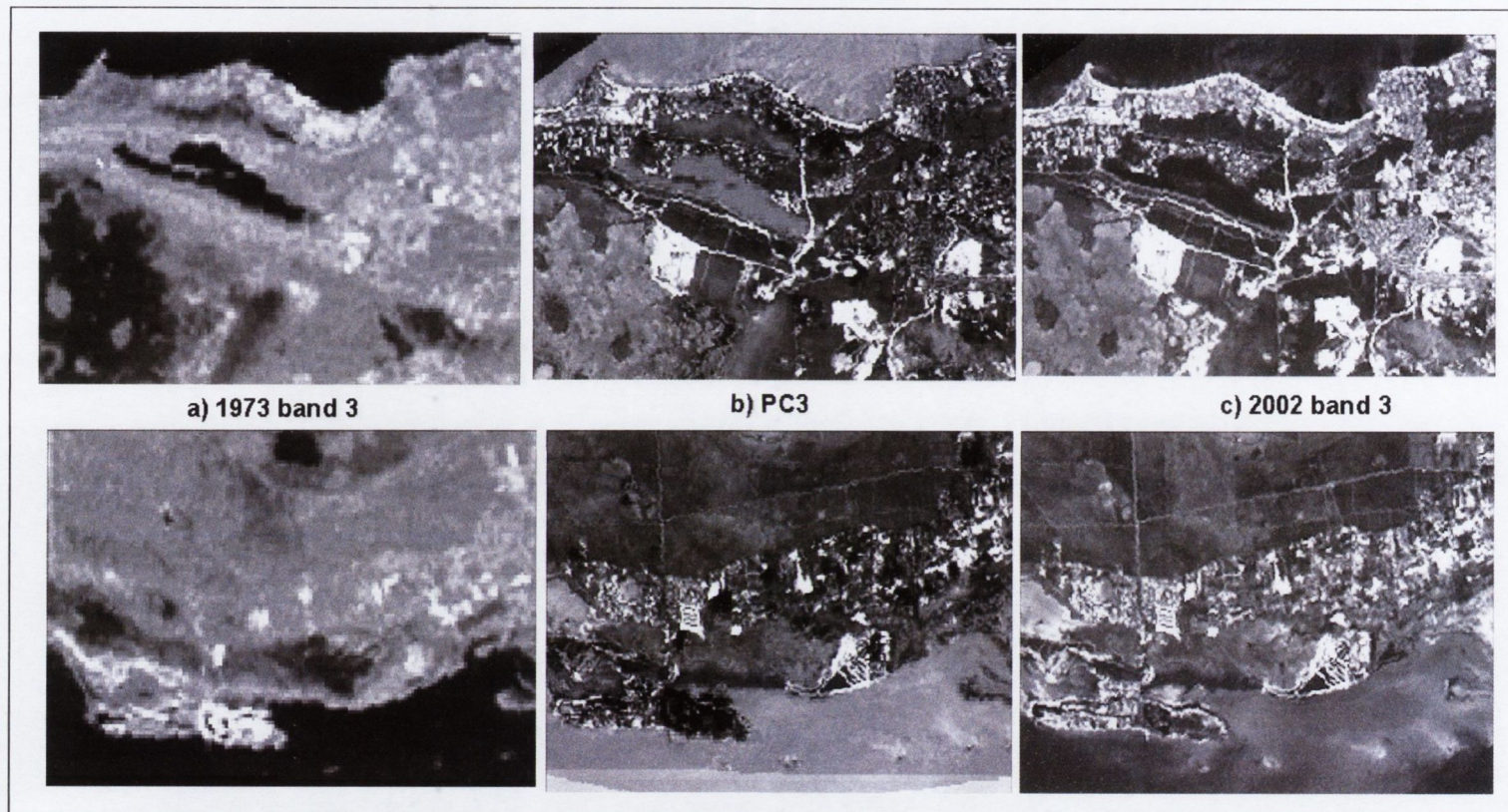


Figure 7.4. A comparison of spectral signatures from a) Landsat MSS 1973 band 3 b) PC3 generated from a multitemporal PCA of the brightness time series 1973-1986-1999-2002 and c) Landsat ETM+ 2002 band 3 for two subsets of the study area.

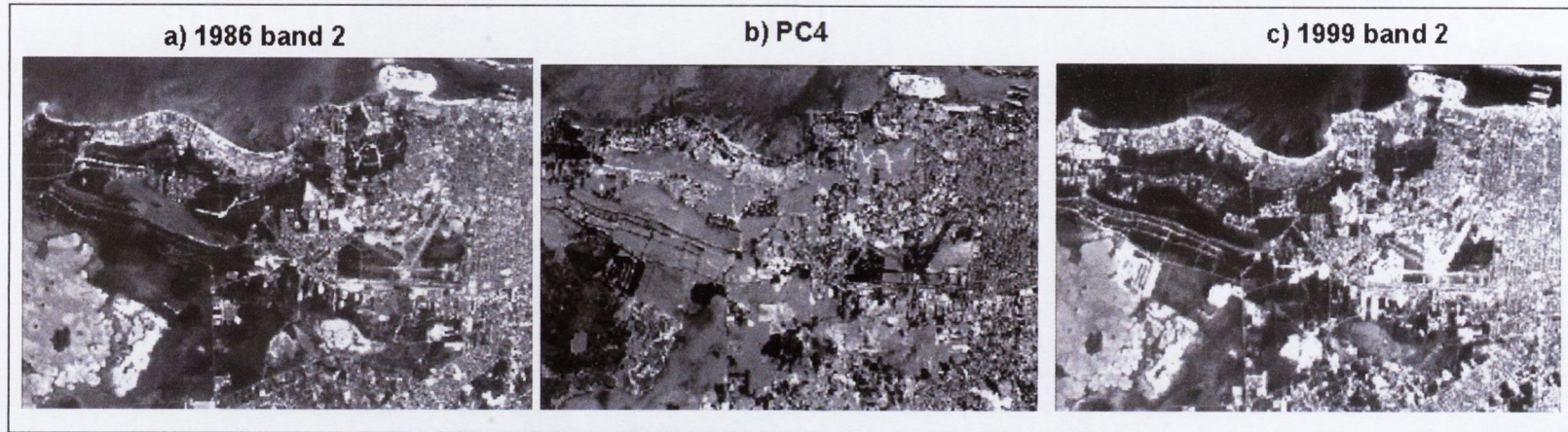


Figure 7.5. A comparison of spectral signatures from a) SPOT HRV 1986 band 2 b) PC4 generated from a multitemporal PCA of the brightness time series 1973-1986-1999-2002 and c) SPOT HRVIR 1999 band 2 for a subset of the study area.

Table 7.17. Percent contribution by each input year to the greenness PC images.

Year	PC1	PC2	PC3	PC4
1973	10.94	0.51	4.48	84.07
1986	23.36	73.00	1.73	1.91
1999	43.59	24.85	17.59	13.97
2002	22.11	1.64	76.20	0.05

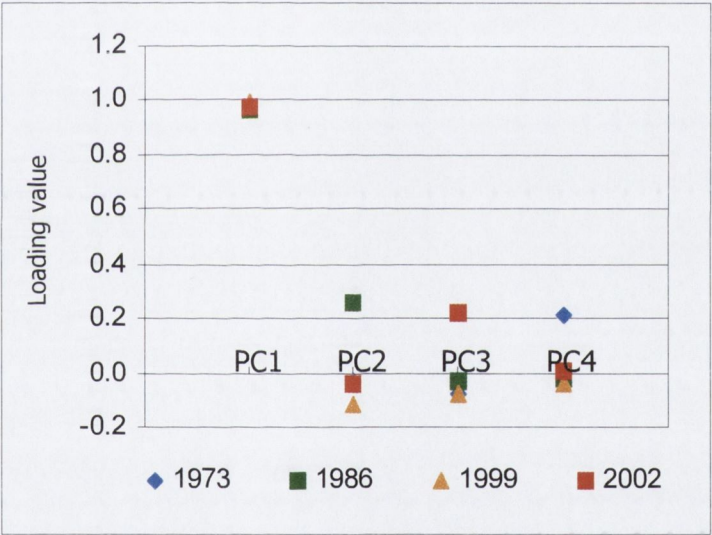


Figure 7.6. Degree of correlation (factor loading values) between input years and greenness PC images.

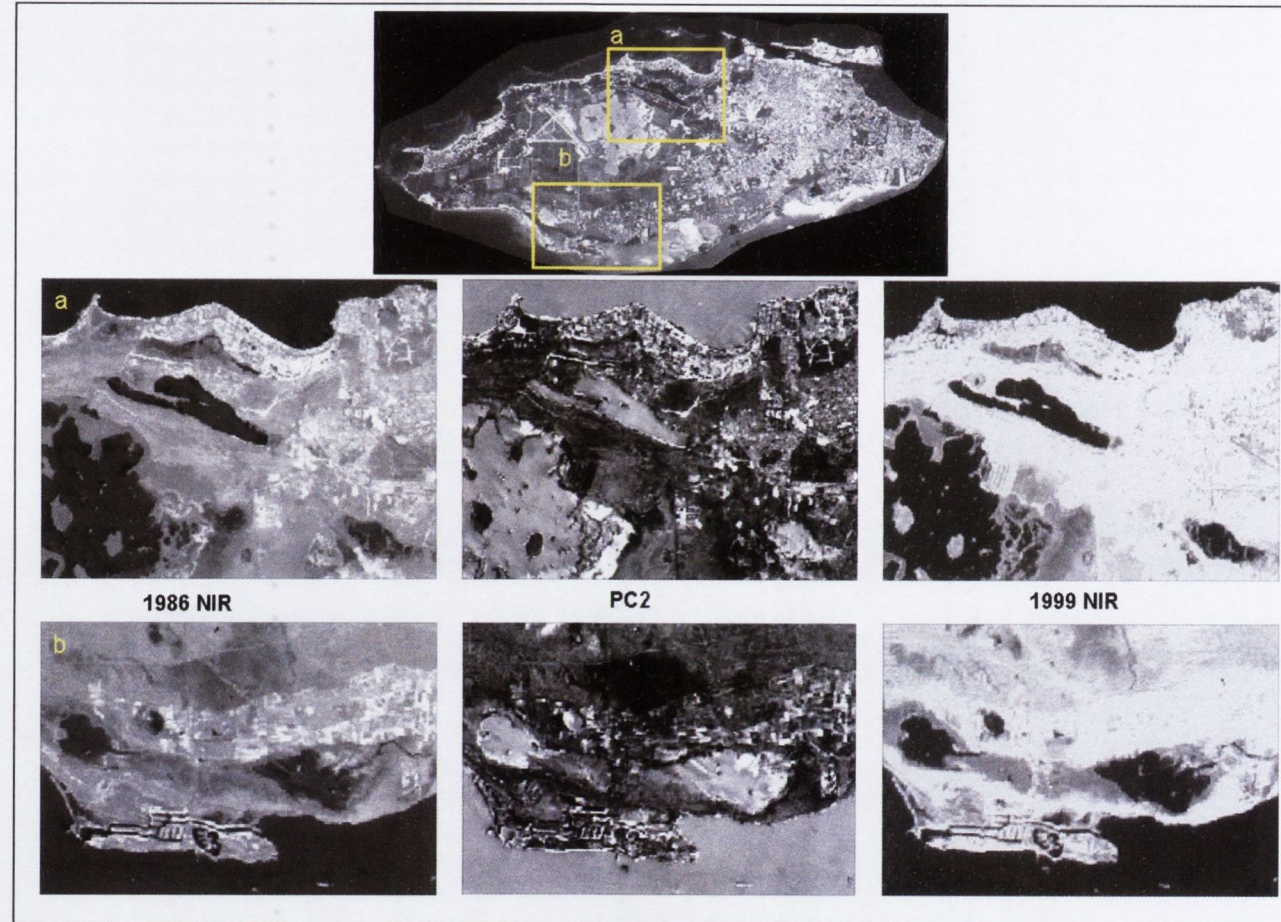


Figure 7.7. A comparison of spectral signatures from SPOT HRV 1986 NIR, PC2 generated from a multitemporal PCA of the greenness time series 1973-1986-1999-2002 and SPOT HRVIR 1999.

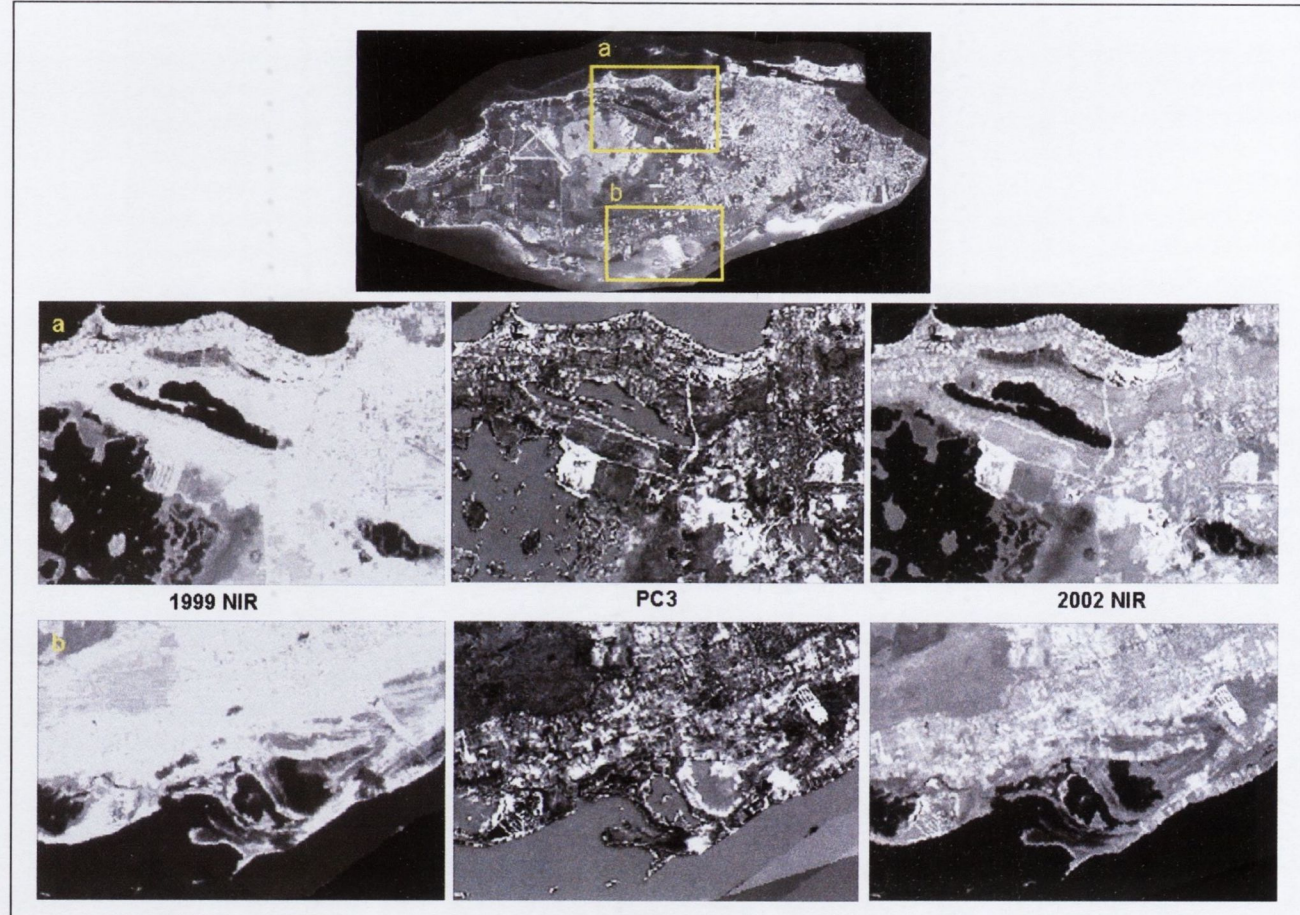


Figure 7.8. A comparison of spectral signatures from SPOT HRV 1999 NIR, PC3 generated from a multitemporal PCA of the greenness time series 1973-1986-1999-2002 and Landsat ETM+ 2002 NIR.

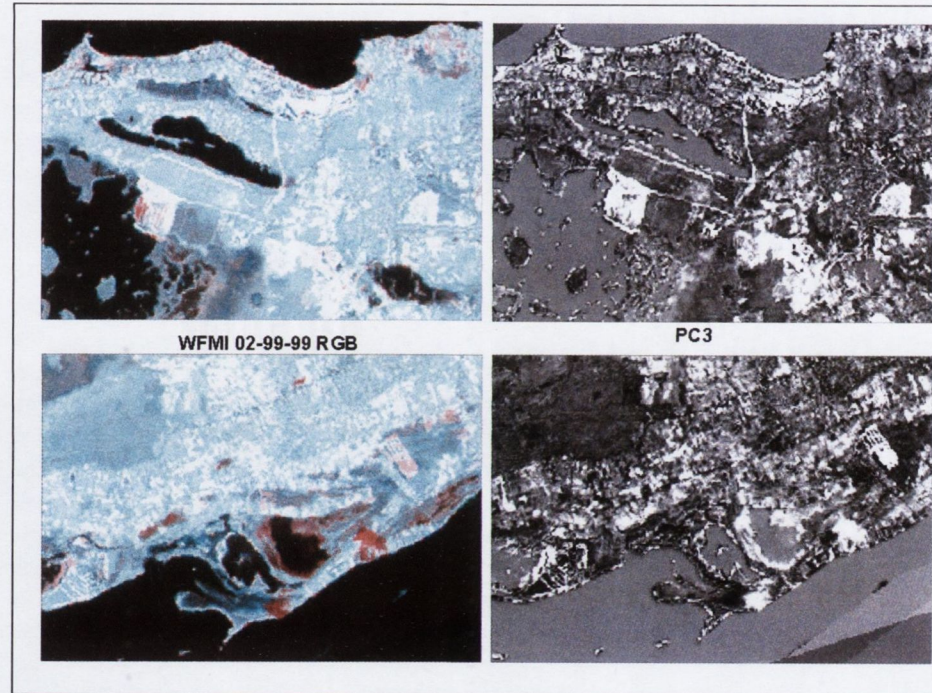


Figure 7.9. A comparison of a WFI image generated to display differences in spectral reflectance values recorded in the NIR in 1999 (SPOT HRVIR) and 2002 (Landsat ETM+); and PC3 produced from multitemporal PCA on the greenness 1973-1986-1999-2002 time series.

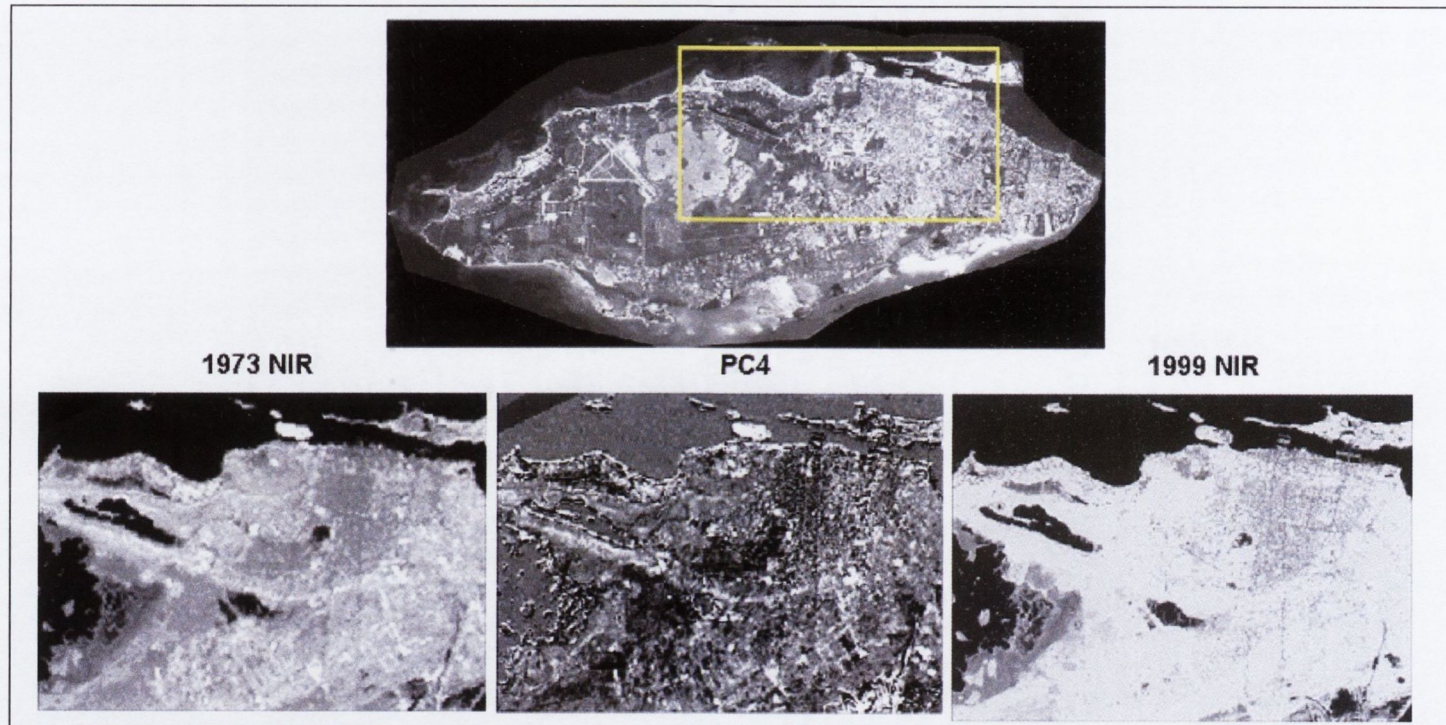


Figure 7.10. A comparison of spectral signatures from Landsat MSS 1973, PC4 generated from a multitemporal PCA of the greenness time series 1973-1986-1999-2002 and SPOT HRVIR 1999.

Table 7.18. **Percent contribution by input year to the NDVI PC images.**

Year	PC1	PC2	PC3	PC4
1973	29.54	63.56	6.44	0.46
1986	17.91	1.62	7.79	72.68
1999	31.26	5.31	37.25	26.19
2002	21.29	29.50	48.53	0.67

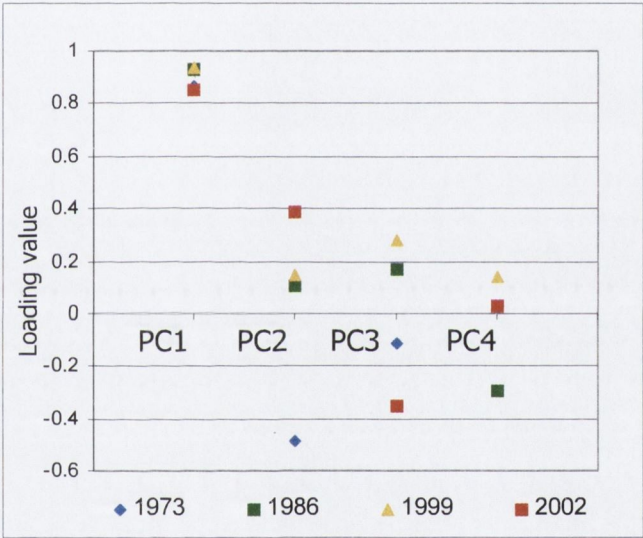


Figure 7.11. **Degree of correlation (factor loading values) between input years and NDVI PC images.**

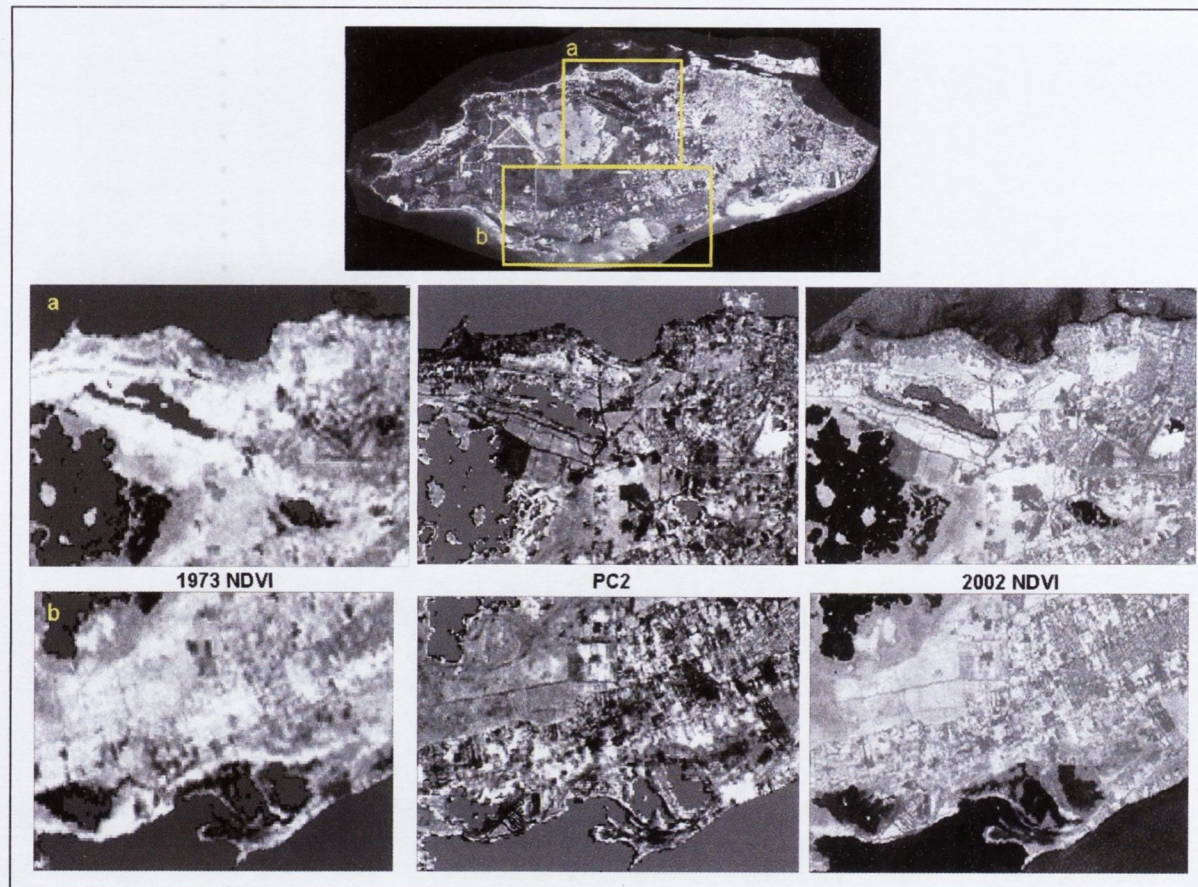


Figure 7.12. A comparison of spectral signatures from Landsat MSS 1973, PC2 generated from a multitemporal PCA on the NDVI time series 1973-1986-1999-2002 and Landsat ETM+ 2001.

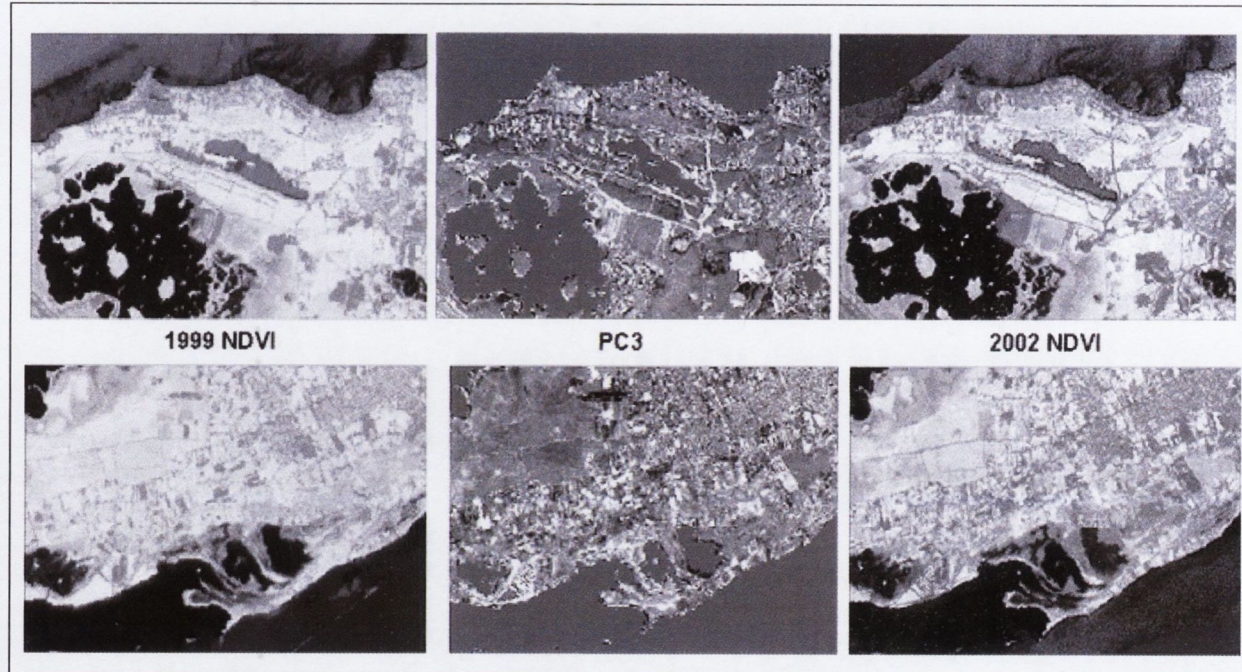


Figure 7.13. A comparison of spectral signatures from SPOT HRVIR 1999, PC3 generated from a multitemporal PCA on the NDVI time series 1973-1986-1999-2002 and Landsat ETM+ 2002 for two subsets of the study area.

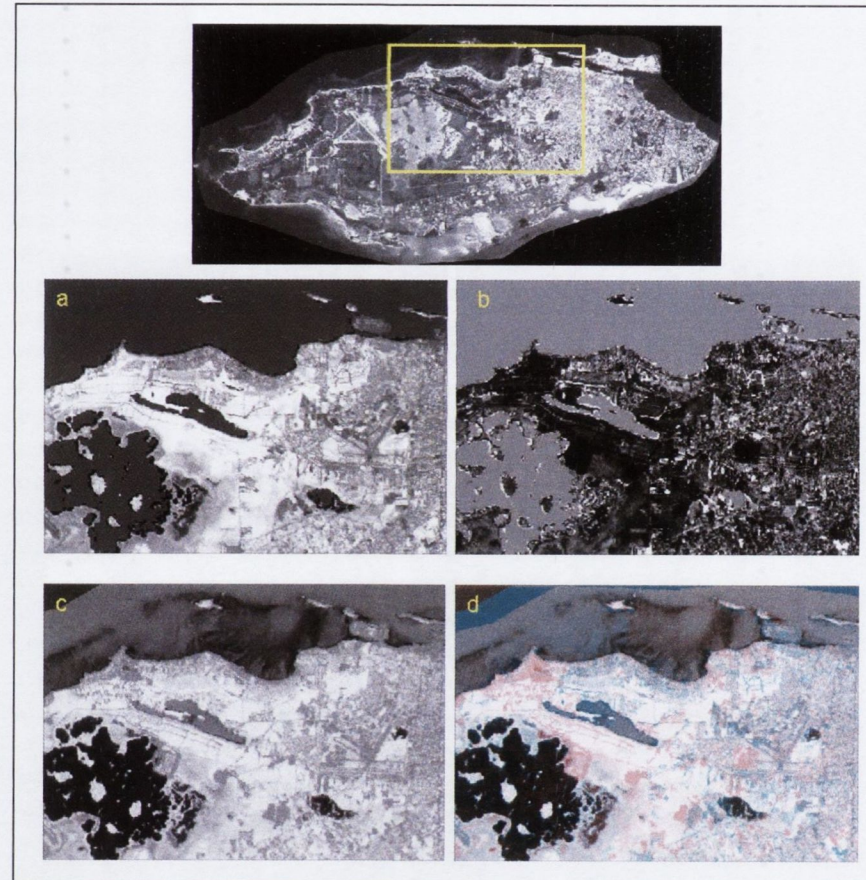


Figure 7.14. A comparison of spectral signatures from a) SPOT HRV 1986 b) PC4 generated from a multitemporal PCA on the NDVI time series 1973-1986-1999-2002 c) SPOT HRVIR 1999 and d) a WFMI image generated using NDVI values from 1986 and 1999.

Table 7.19 A summary of landscape change information highlighted within PC images derived from multitemporal PCA applied to a time series of brightness, greenness and NDVI imagery for the years 1973-1986-1999-2002.

Period of change highlighted	PC image number	Information content (%)	Time series
1973-2002	PC3	7.3	Brightness
	PC2	11.9	NDVI
1973-1986	PC2	9.1	Brightness
1973-1999	PC4	0.6	Greenness
1986-1999	PC4	5.3	Brightness
	PC2	2.1	Greenness
	PC4	2.0	NDVI
1999-2002	PC3	1.3	Greenness
	PC3	6.0	NDVI

Table 7.20. Percent of total input band variance explained by principal components produced by multitemporal PCA (1985-1999-2001-2002).

Multitemporal PCA method	Principal Component number			
	1	2	3	4
Brightness	86.8	7.1	4.3	1.8
Greenness	95.2	2.2	1.9	0.7
NDVI	77.3	14.3	6.4	2.0

Table 7.21. Percent contribution by input year to the brightness PC images.

Year	PC1	PC2	PC3	PC4
1985	14.72	0.98	83.43	0.86
1999	21.08	70.69	8.20	0.04
2001	29.15	9.89	1.30	59.66
2002	35.05	18.44	7.08	39.44

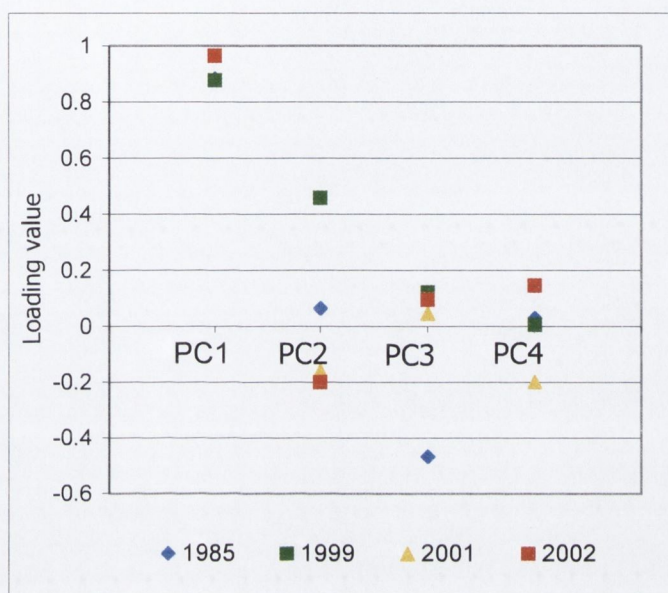


Figure 7.15. Degree of correlation (factor loading values) between input years and brightness PC images.

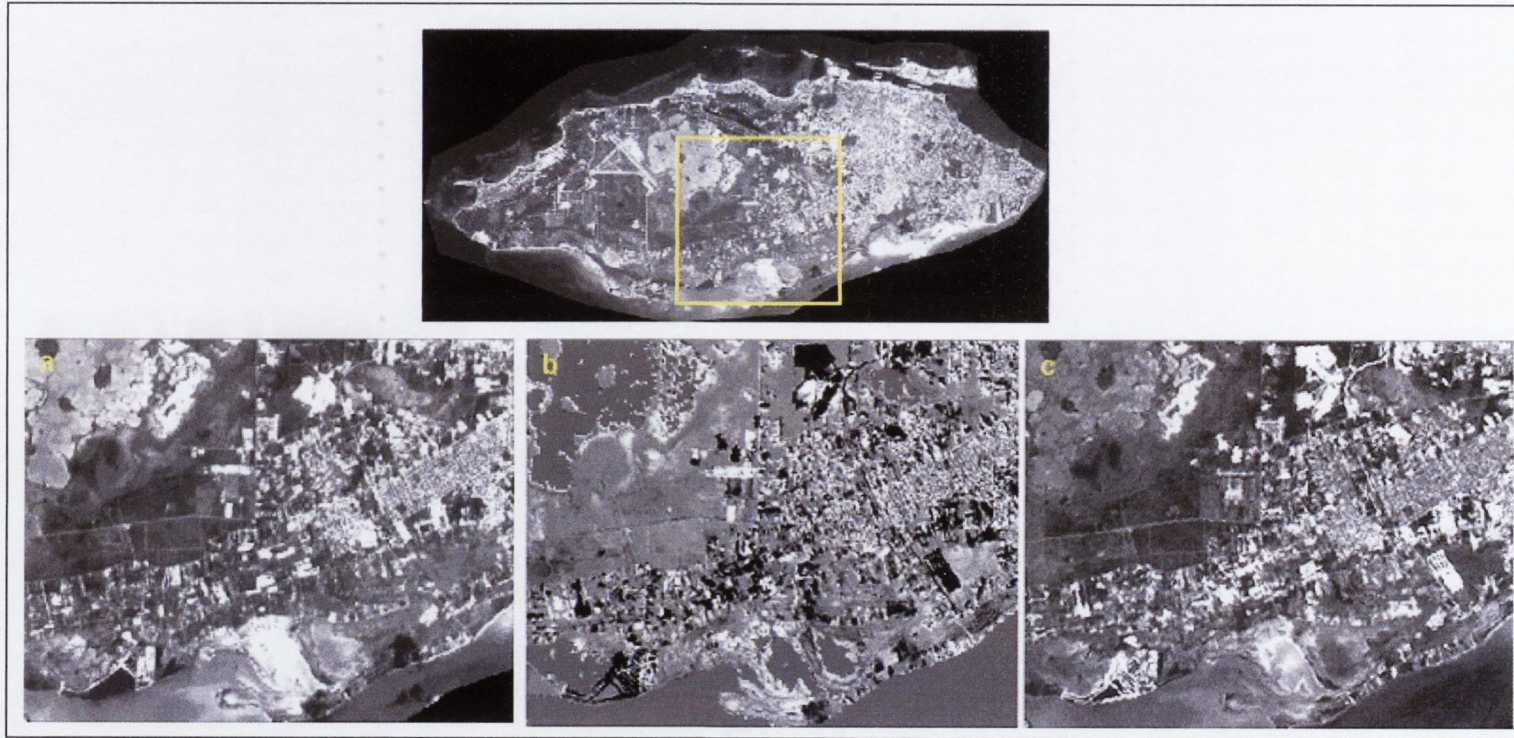


Figure 7.16. A comparison of spectral signatures from a) SPOT HRVIR 1999 band 2 b) PC2 generated from a multitemporal PCA on the brightness time series 1985-1999-2001-2002 and c) Landsat ETM+ 2002 band 3.

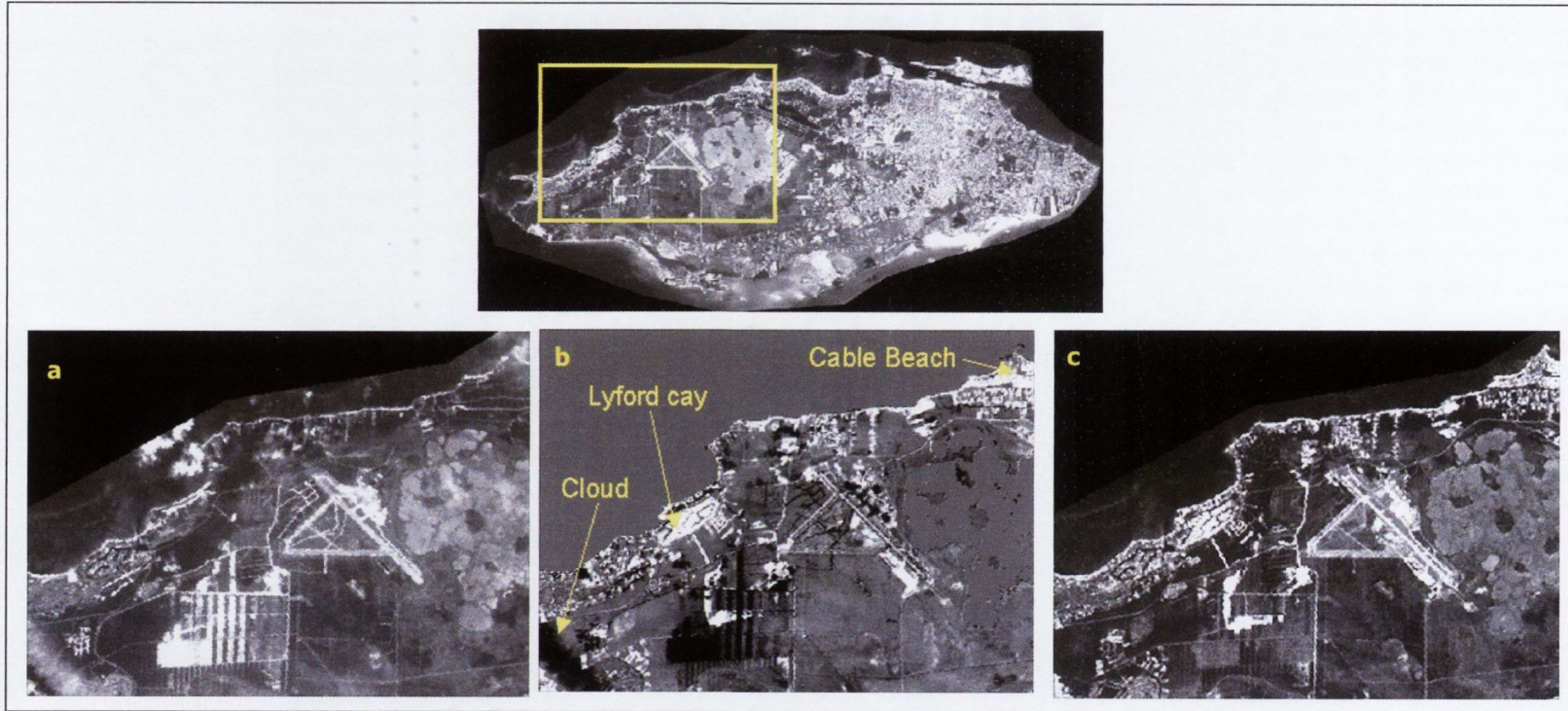


Figure 7.17. A comparison of spectral signatures from a) Landsat TM band 3 b) PC3 generated from a multitemporal PCA on the brightness time series 1985-1999-2001-2002 and c) Landsat ETM+ 2002 band 3.

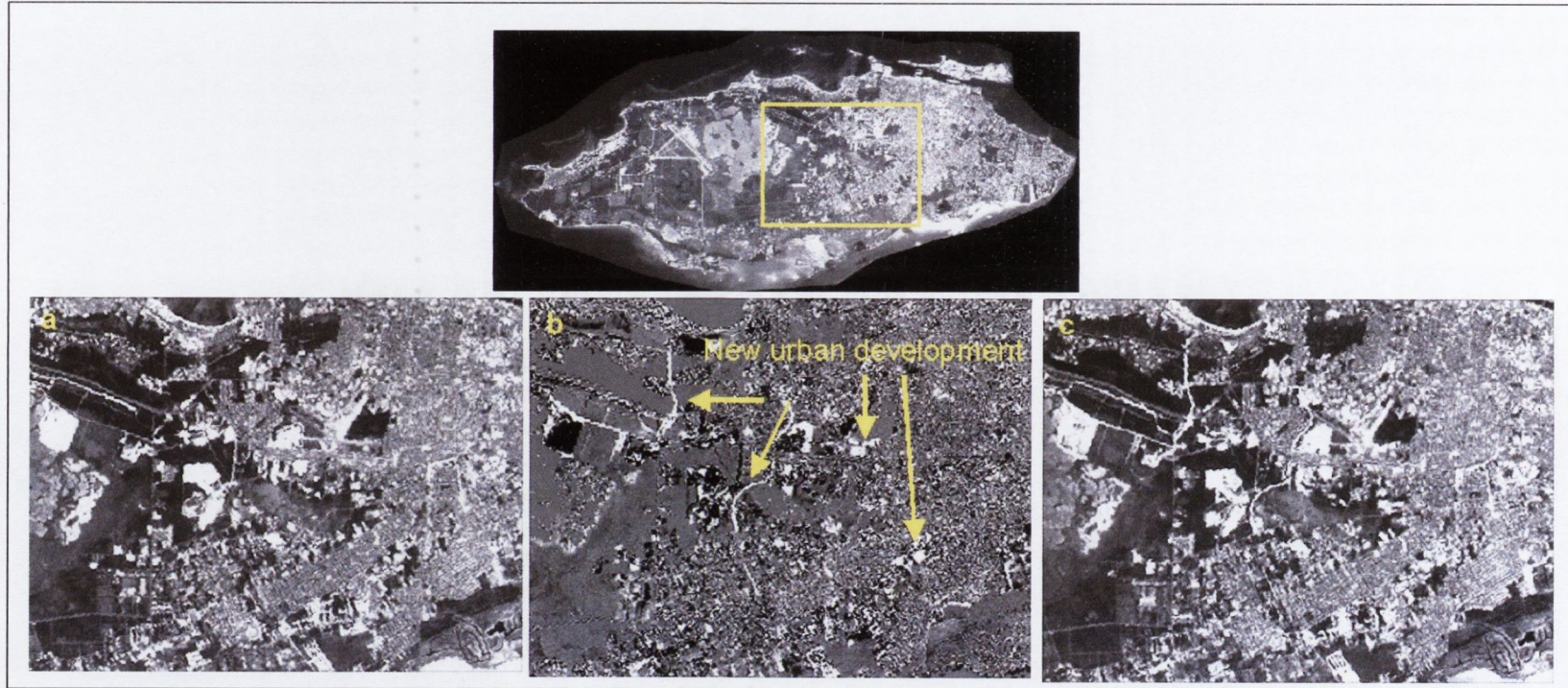


Figure 7.18. A comparison of spectral signatures from a) Landsat ETM+ 2001 band 3 b) PC4 generated from a multitemporal PCA on the brightness time series 1985-1999-2001-2002 and c) Landsat ETM+ 2002 band 3.

Table 7.22. Percent contribution by input year to the greenness PC images.

Year	PC1	PC2	PC3	PC4
1985	22.62	68.35	8.42	0.62
1999	40.50	29.68	28.79	1.03
2001	15.72	0.15	32.09	52.04
2002	21.16	1.82	30.70	46.32

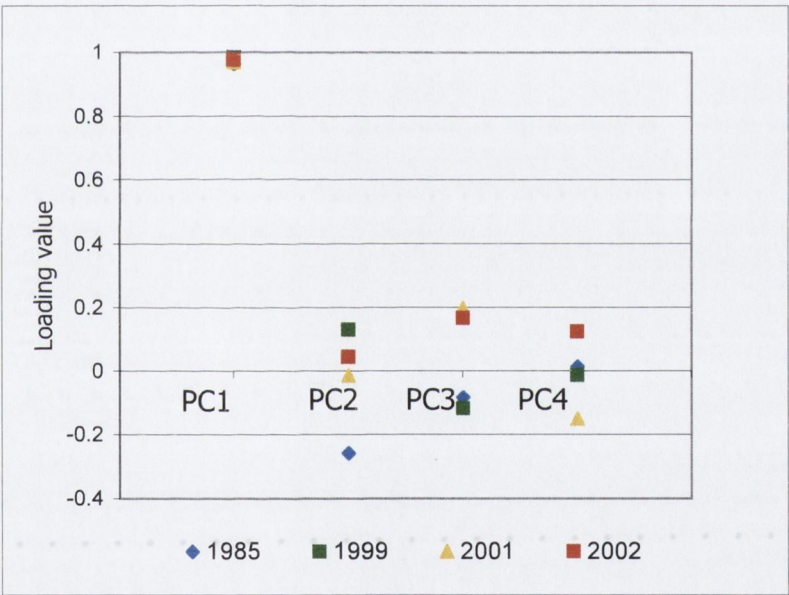


Figure 7.19. Degree of correlation (factor loading values) between input years and greenness PC images.

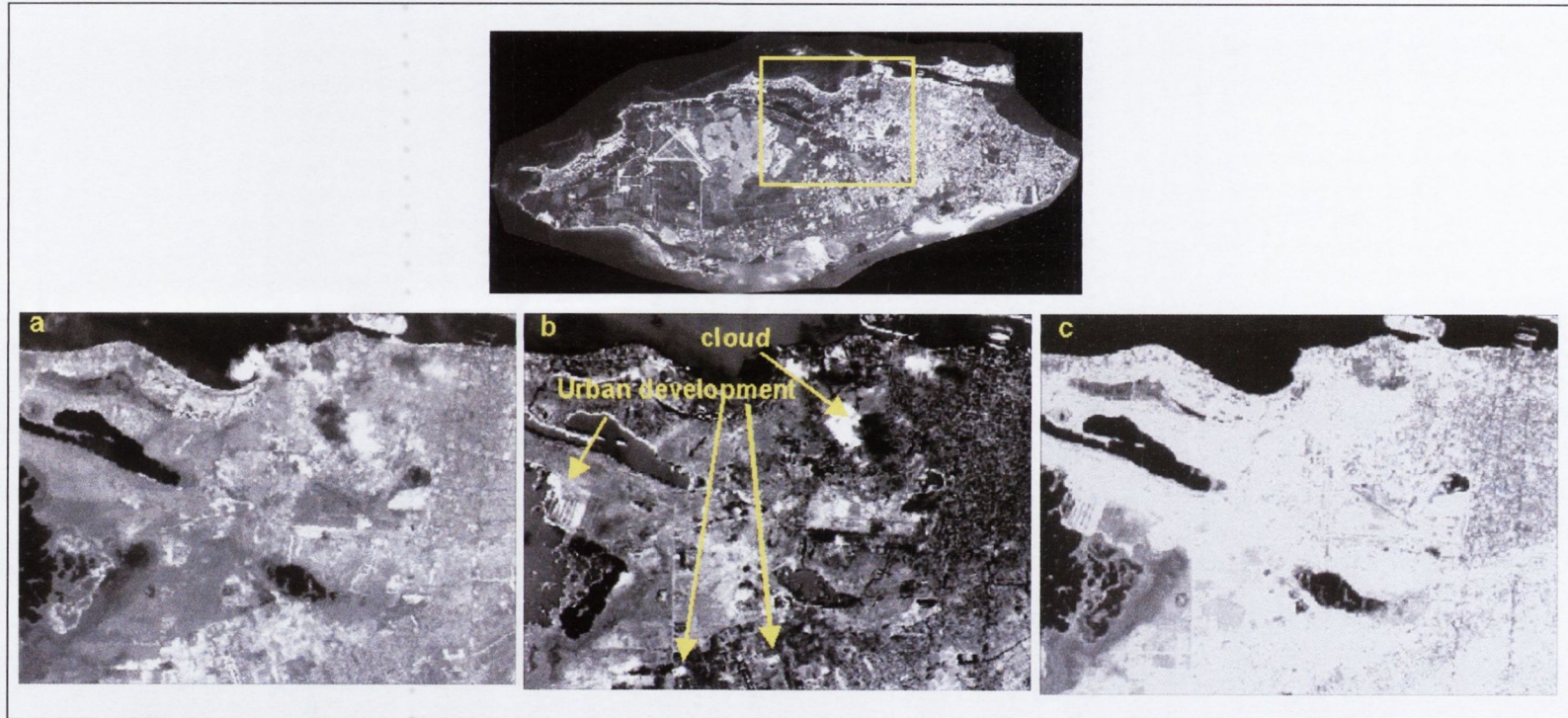


Figure 7.20. A comparison of spectral signatures from a) Landsat TM 1985 band 4 b) PC2 generated from a multitemporal PCA on the greenness time series 1985-1999-2001-2002 and c) SPOT HRVIR 1999 band 3.

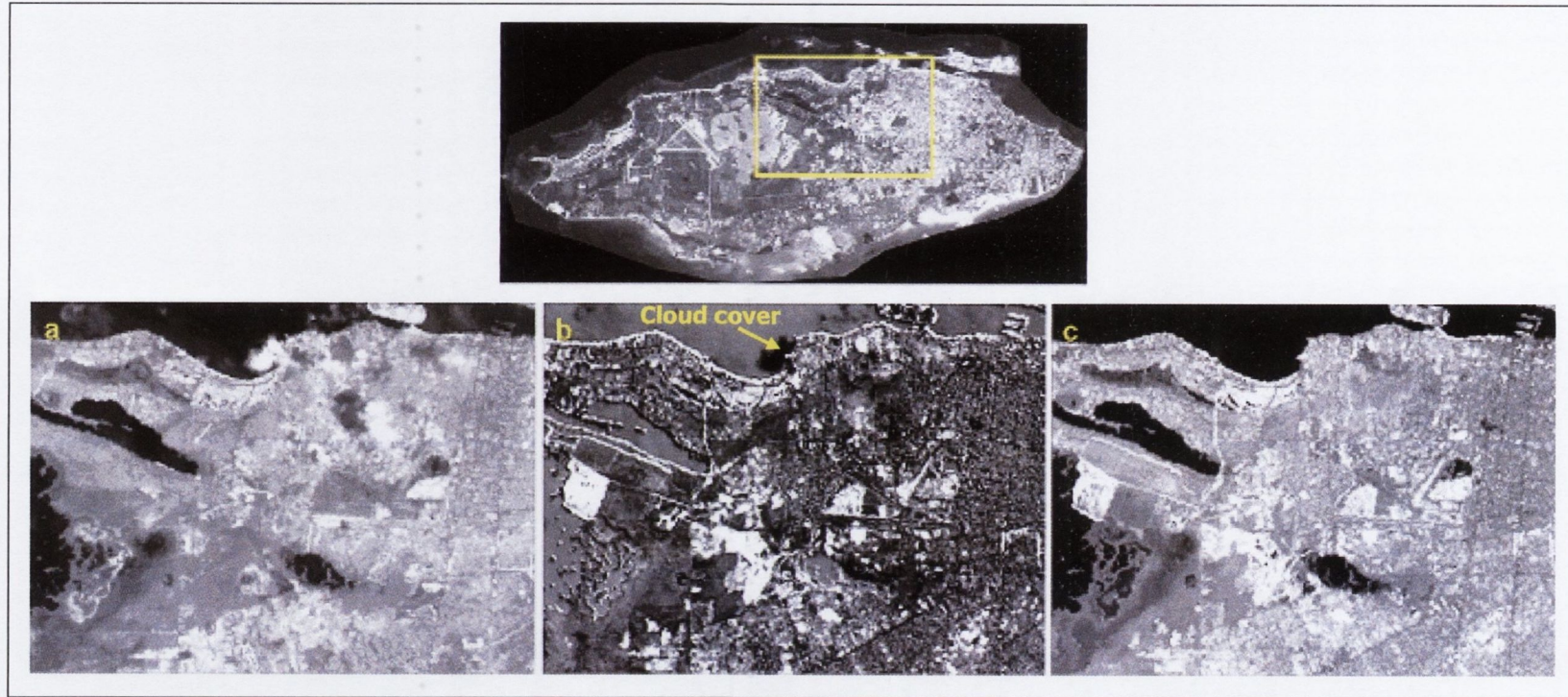


Figure 7.21. A comparison of spectral signatures from a) Landsat TM 1985 band 4 b) PC3 generated from a multitemporal PCA on the greenness time series 1985-1999-2001-2002 and c) Landsat ETM+ 2002 band 4 for a subset of New Providence, The Bahamas.

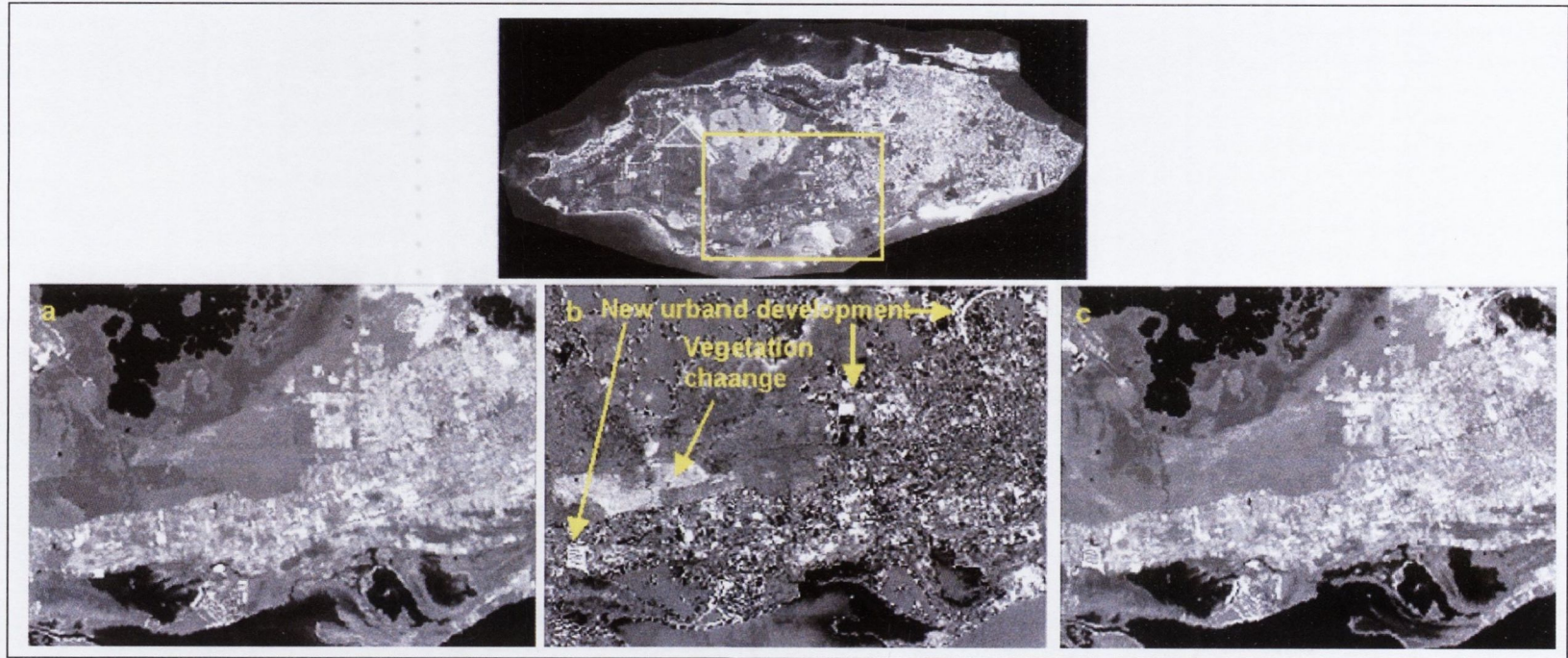


Figure 7.22. A comparison of spectral signatures from a) Landsat ETM+ 2001 band 4 b) PC4 generated from a multitemporal PCA on the greenness time series 1985-1999-2001-2002 and c) Landsat ETM+ 2002 band 4.

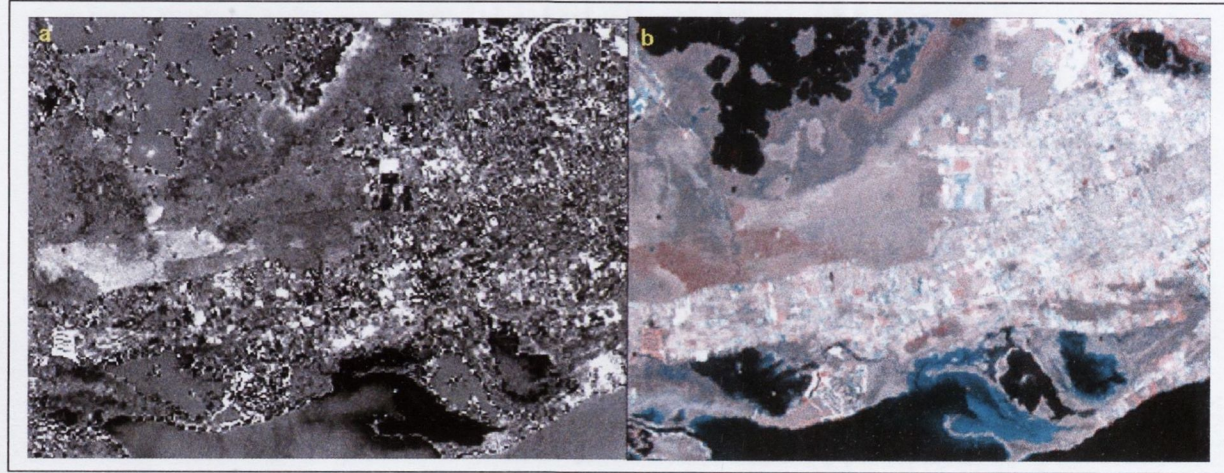


Figure 7.23. A comparison of a) PC4 produced from multitemporal PCA on the greenness 1985-1999-2001-2002 time series and b) a WFMI image generated to display differences in spectral reflectance values recorded by Landsat ETM+ band 4 in 2001 and 2002.

Table 7.23. Percent contribution by input year to the NDVI PC images.

Year	PC1	PC2	PC3	PC4
1985	14.77	5.56	4.31	75.37
1999	30.87	17.10	28.43	23.59
2001	31.04	68.75	0.13	0.09
2002	23.33	8.58	67.14	0.95

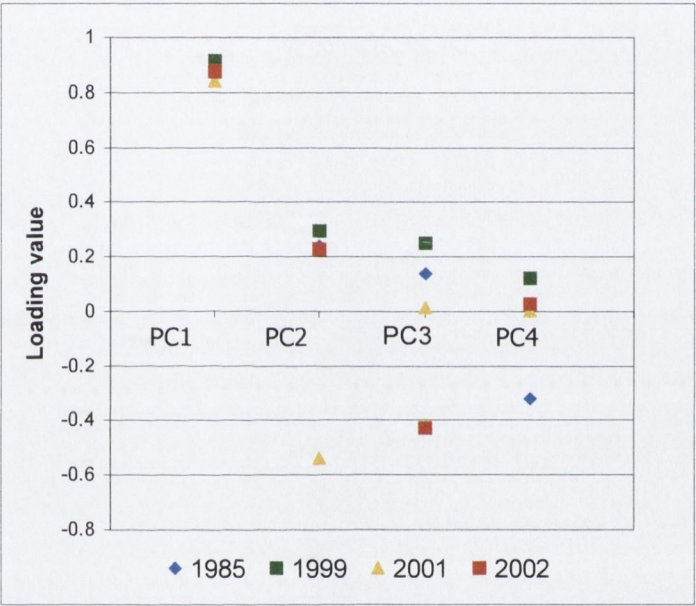


Figure 7.24. Degree of correlation (factor loading values) between input years and NDVI PC images.

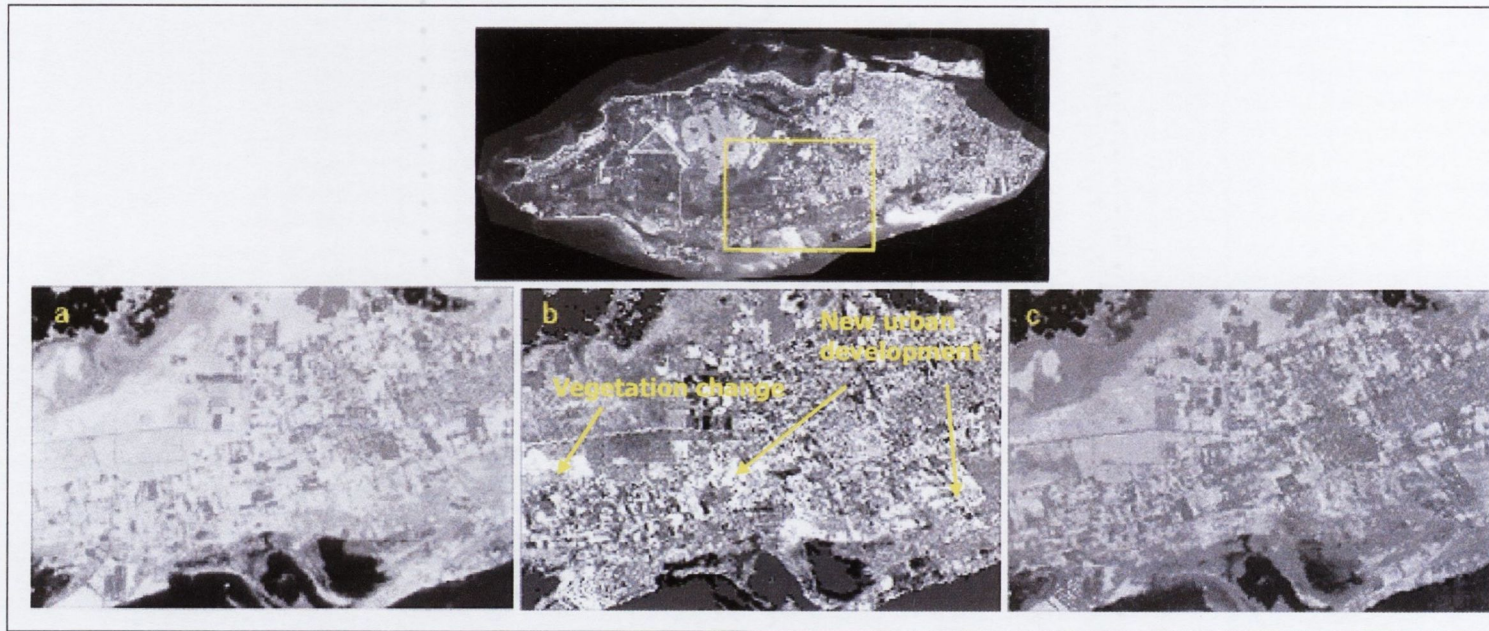


Figure 7.25. A comparison of spectral signatures from a) SPOT HRVIR 1999 NDVI b) PC2 generated from a multitemporal PCA on the NDVI time series 1985-1999-2001-2002 and c) Landsat ETM+ 2001 NDVI.

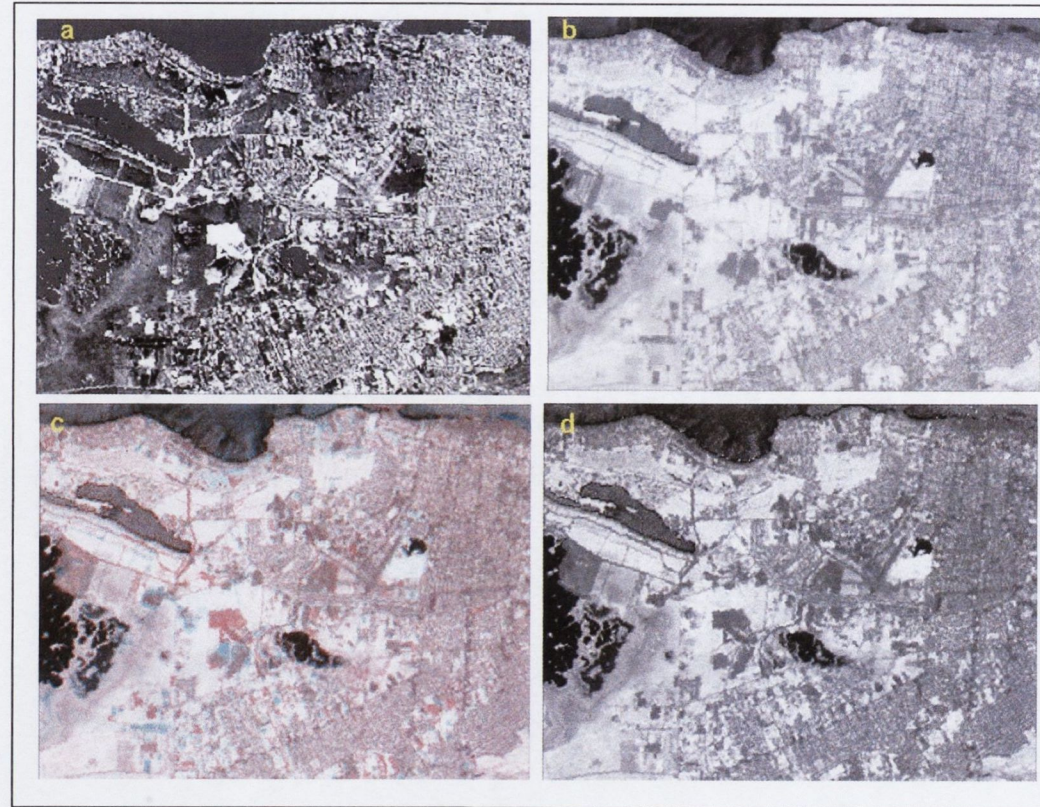


Figure 7.26. A comparison of spectral signatures from a) PC3 generated from a multitemporal PCA on the NDVI time series 1985-1999-2001-2002 b) SPOT HRVIR 1999 NDVI c) a WFMI image of 1999 and 2002 NDVI and d) Landsat ETM+ 2002 NDVI.

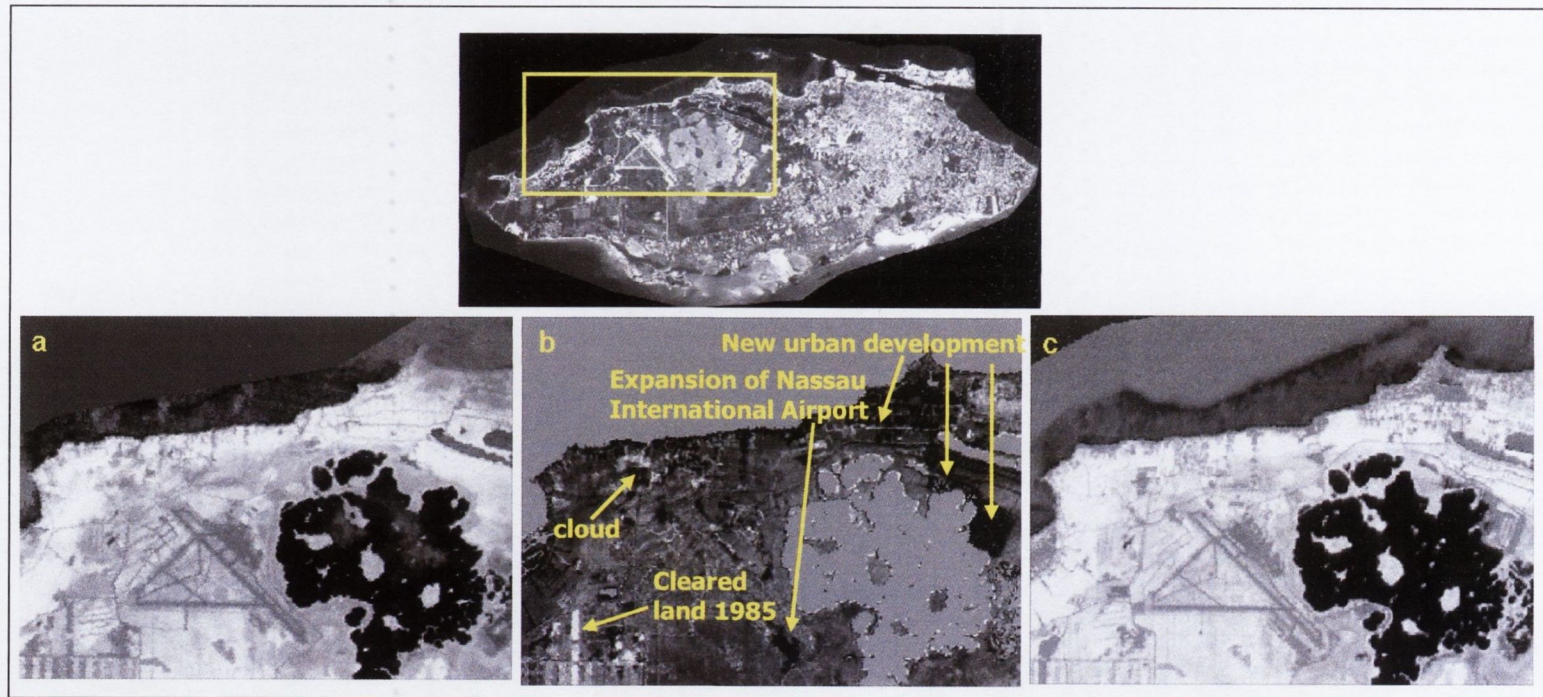


Figure 7.27. A comparison of spectral signatures from a) Landsat TM 1985 NDVI b) PC4 generated from a multitemporal PCA on the NDVI time series 1985-1999-2001-2002 and c) SPOT HRVIR 1999 NDVI.

Table 7.24. A summary of landscape change information highlighted within PC images derived from multitemporal PCA applied to a time series of brightness, greenness and NDVI imagery for the years 1985-1999-2001-2002.

Period of change highlighted	PC image number	Information content (%)	Time series
1985-1999	PC3	4.3	Brightness
	PC2	2.2	Greenness
	PC4	2.0	NDVI
1985-2002	PC3	1.9	Greenness
1999-2001	PC2	14.3	NDVI
1999-2002	PC2	7.1	Brightness
	PC3	6.4	NDVI
2001-2002	PC4	1.8	Brightness
	PC4	0.7	Greenness

Table 7.25. Percent of total input band variance explained by principal components produced by multitemporal PCA (1985-1999-2001-2002).

Multitemporal PCA method	Principal Component number			
	1	2	3	4
NDBI	73.8	17.0	5.5	3.7
BI	79.6	10.4	5.6	4.4

Table 7.26. Percent contribution by input year to the NDBI PC images.

Year	PC1	PC2	PC3	PC4
1985	8.80	2.21	83.36	5.63
1999	38.07	51.98	7.83	2.12
2001	25.08	27.77	0.99	46.15
2002	28.05	18.04	7.81	46.11

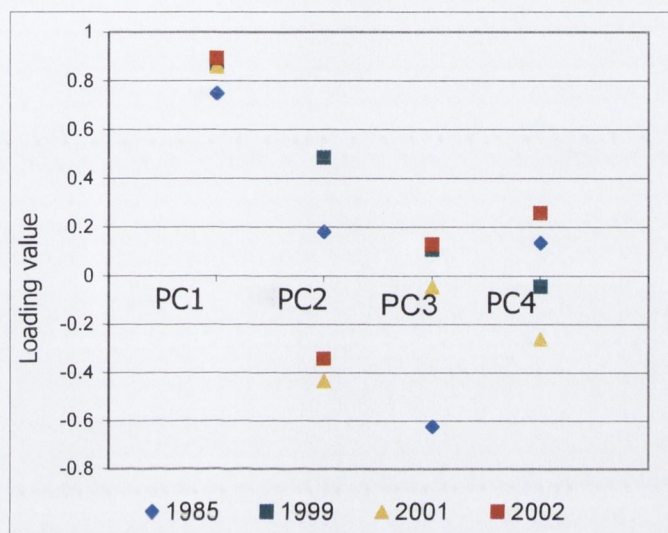


Figure 7.28. Degree of correlation (factor loading values) between input years and PC NDBI images.

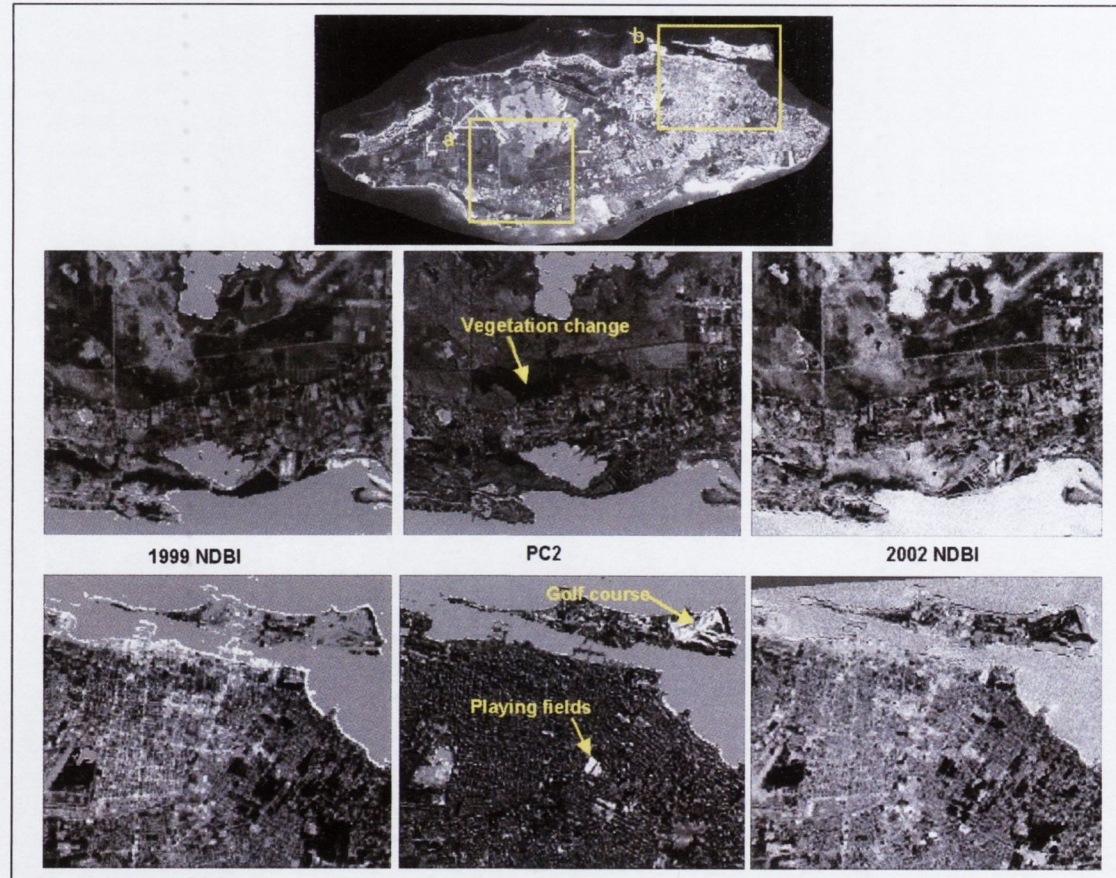


Figure 7.29. A comparison of spectral signatures from SPOT HRVIR 1999 NDBI, PC2 generated from a multitemporal PCA on the NDBI time series 1985-1999-2001-2002 and Landsat ETM+ 2002 NDBI.

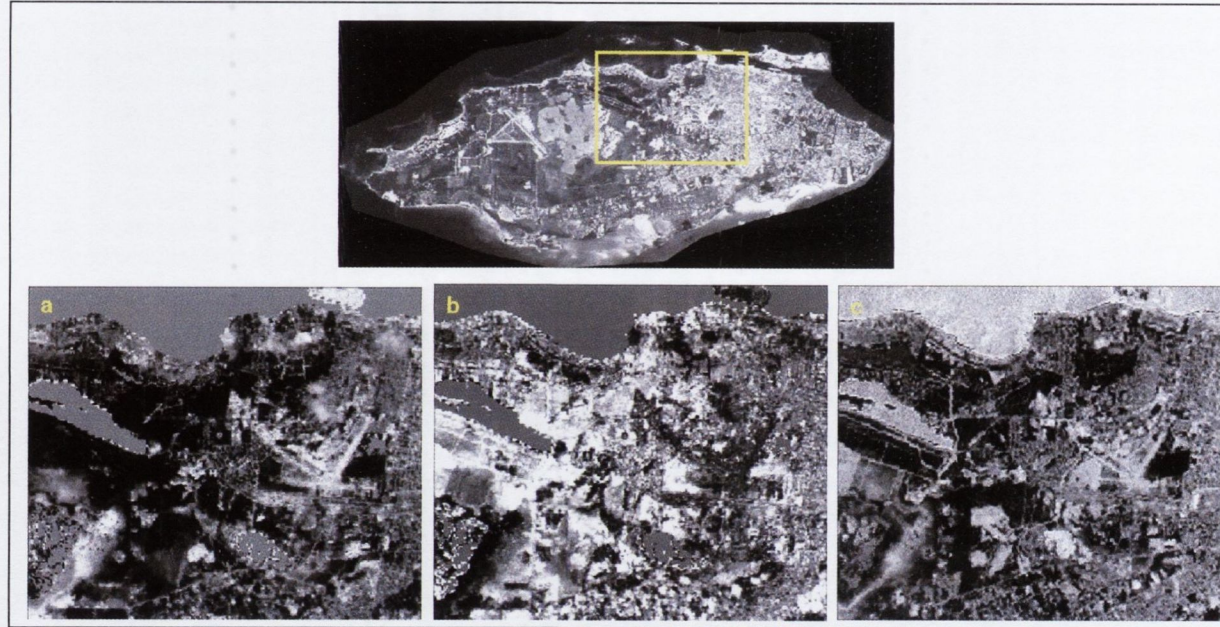


Figure 7.30. A comparison of spectral signatures from a) Landsat TM 1985 NDBI b) PC3 generated from a multitemporal PCA on the NDBI time series 1985-1999-2001-2002 and c) Landsat ETM+ 2002 NDBI.

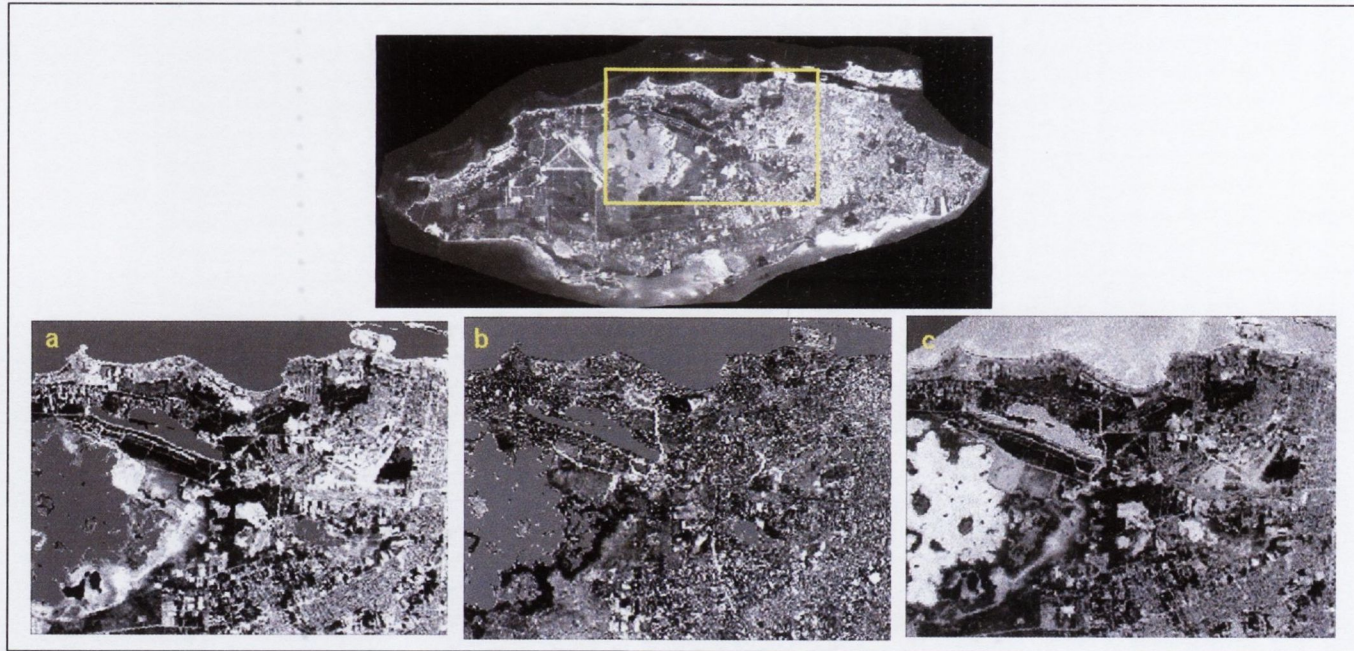


Figure 7.31. A comparison of spectral signatures from a) Landsat ETM+ 2001 NDBI b) PC4 generated from a multitemporal PCA on the NDBI time series 1985-1999-2001-2002 and c) Landsat ETM+ 2002 NDBI.

Table 7.27. Percent contribution by input year to the BI PC images.

Year	PC1	PC2	PC3	PC4
1985	3.99	19.97	61.36	14.69
1999	3.60	71.93	23.54	0.92
2001	41.72	0.80	5.68	51.79
2002	50.69	7.30	9.41	32.61

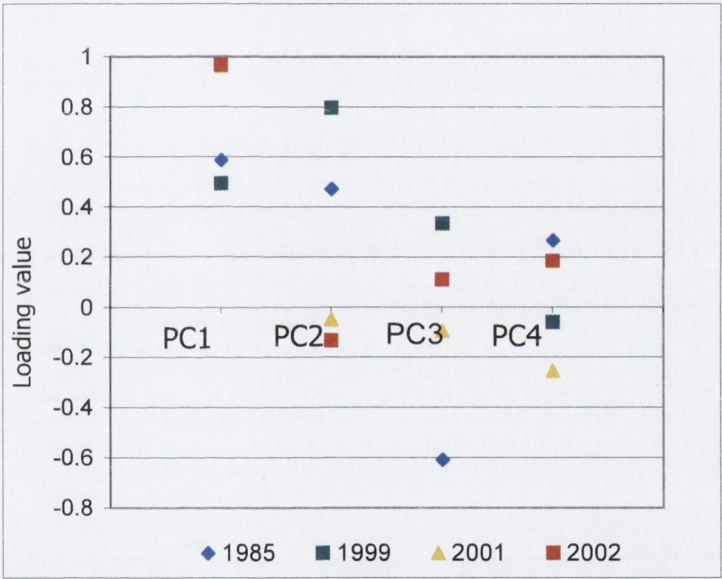


Figure 7.32. Degree of correlation (factor loading values) between input years and PC images for the BI time series 1985-1999-2001-2002.

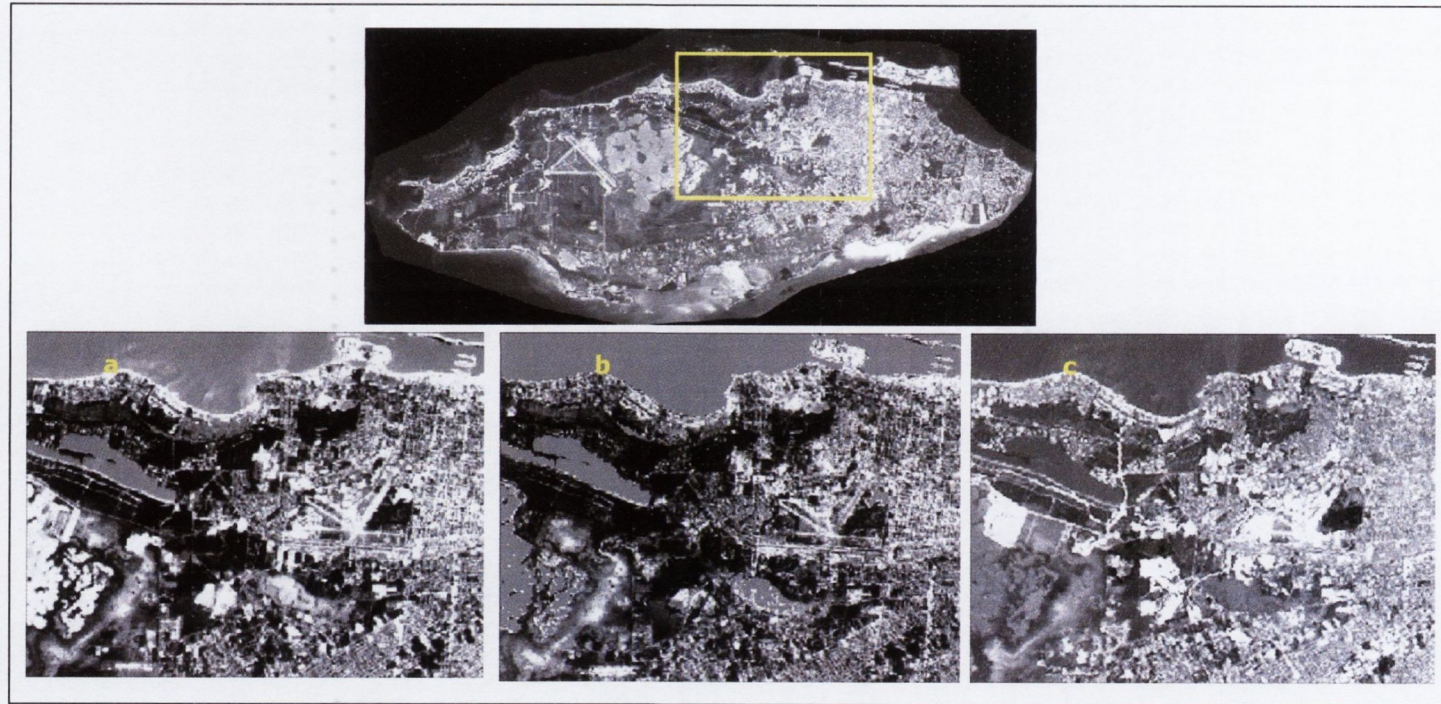


Figure 7.33. A comparison of spectral signatures from a) SPOT HRVIR BI b) PC2 generated from a multitemporal PCA on the BI time series 1985-1999-2001-2002 and c) Landsat ETM+ 2002 BI.

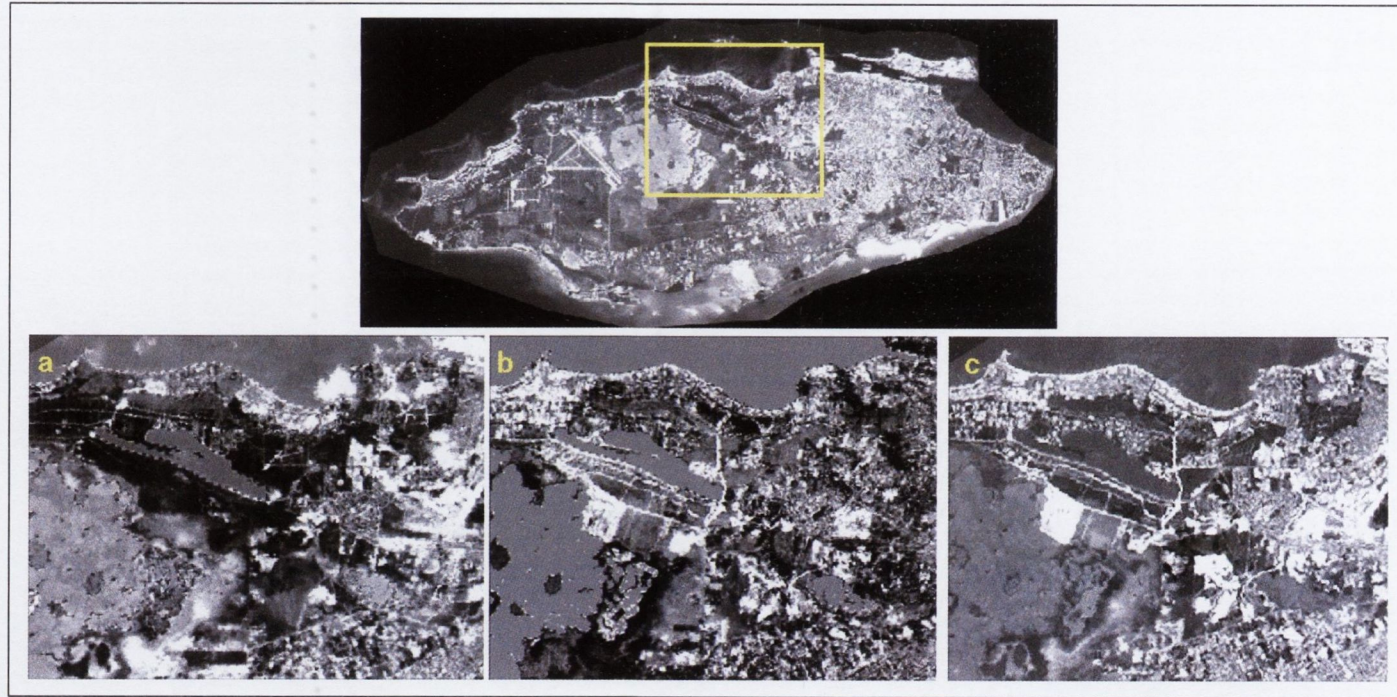


Figure 7.34. A comparison of spectral signatures from a) Landsat TM 1985 BI b) PC3 generated from a multitemporal PCA on the BI time series 1985-1999-2001-2002 and c) Landsat ETM+ 2002 BI.

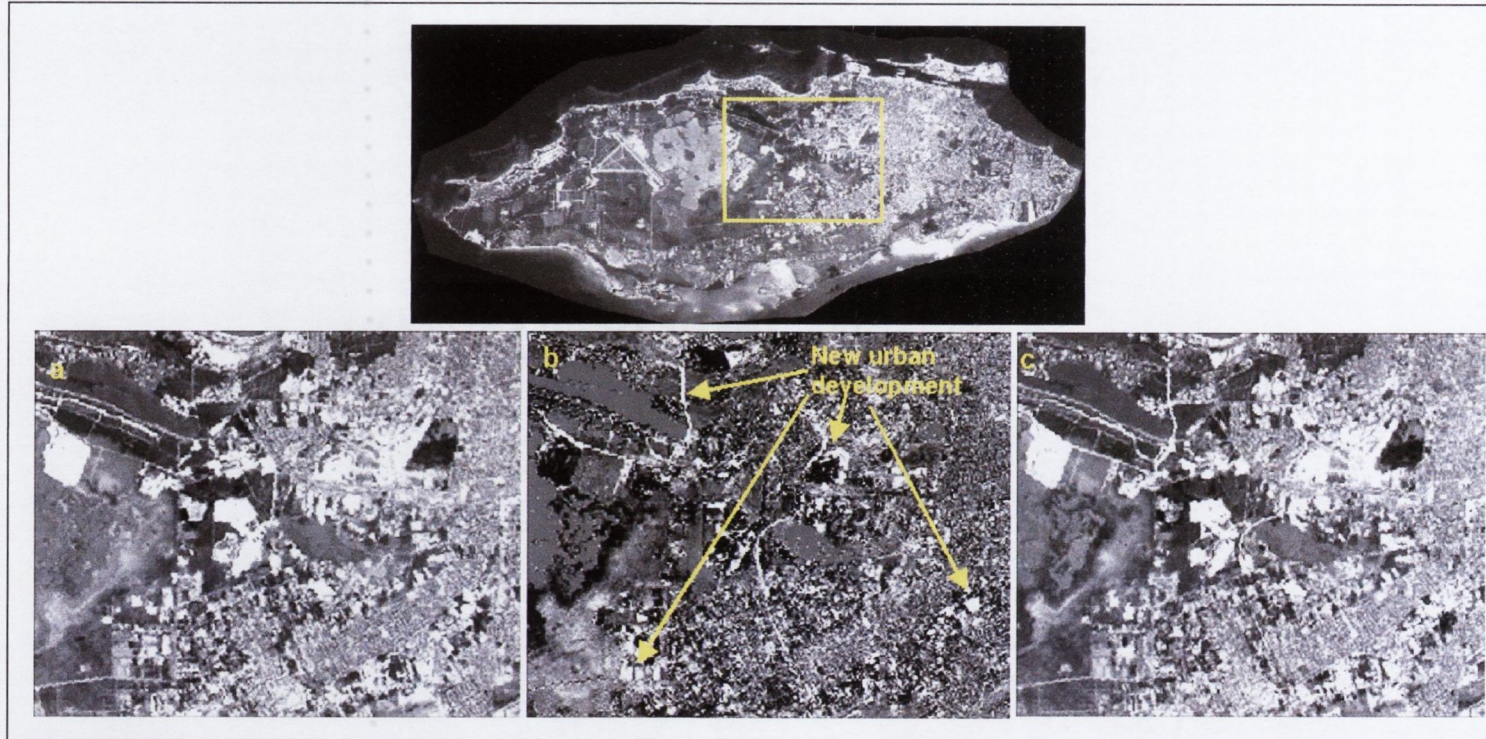


Figure 7.35. A comparison of spectral signatures from a) Landsat ETM+ 2001 BI b) PC4 generated from a multitemporal PCA on the BI time series 1985-1999-2001-2002 and c) Landsat ETM+ 2002 BI.

Table 7.28. A summary of landscape change information highlighted within PC images derived from multitemporal PCA applied to a time series of NDBI and BI imagery for the years 1985-1999-2001-2002.

Period of change highlighted	PC image number	Information content (%)	Time series
1985-2002	PC3	5.5	NDBI
	PC3	5.6	BI
1999-2002	PC2	17.0	NDBI
	PC2	10.4	BI
2001-2002	PC4	3.7	NDBI
	PC4	4.4	BI

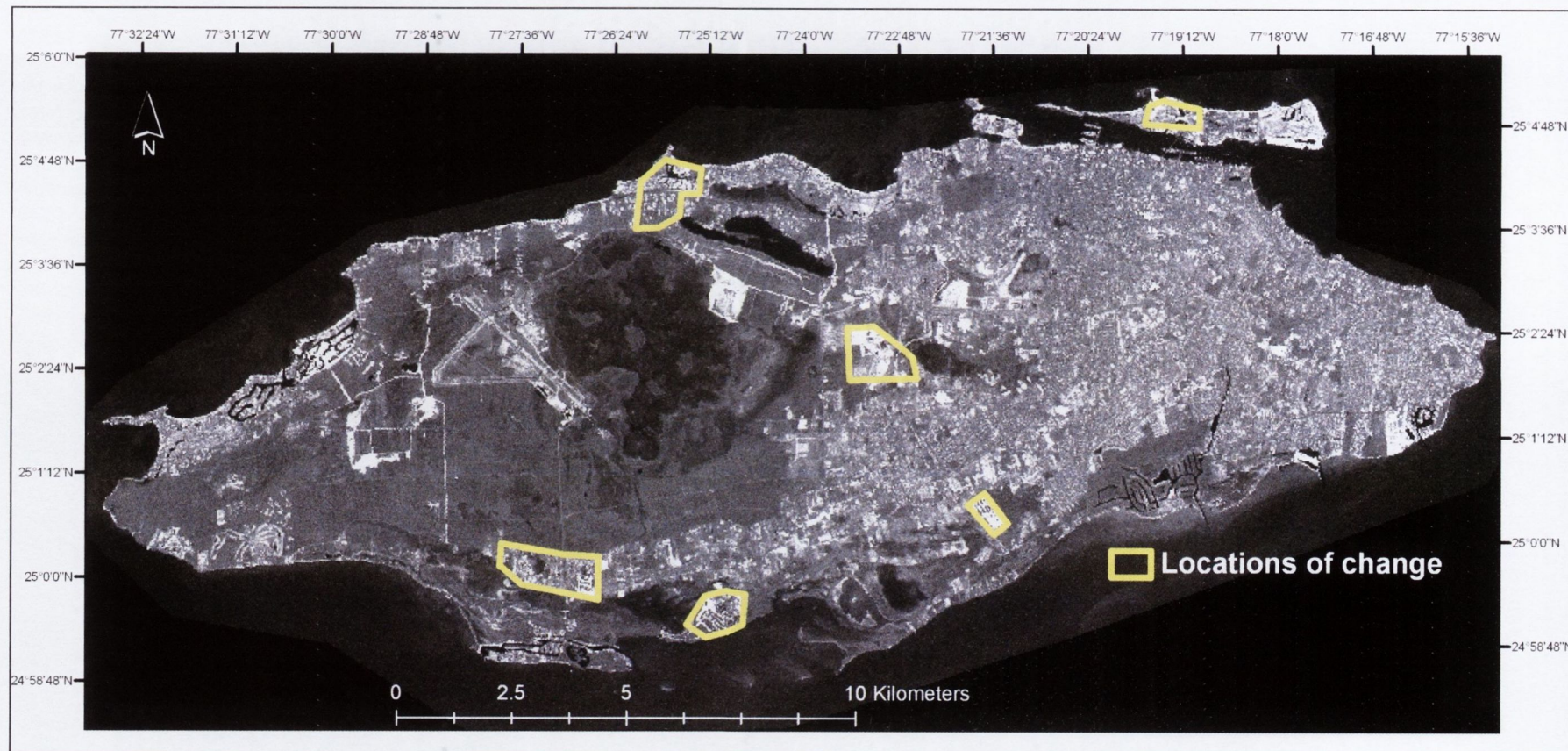


Figure 7.36. Locations of landscape areas exhibiting changed land cover characteristics.

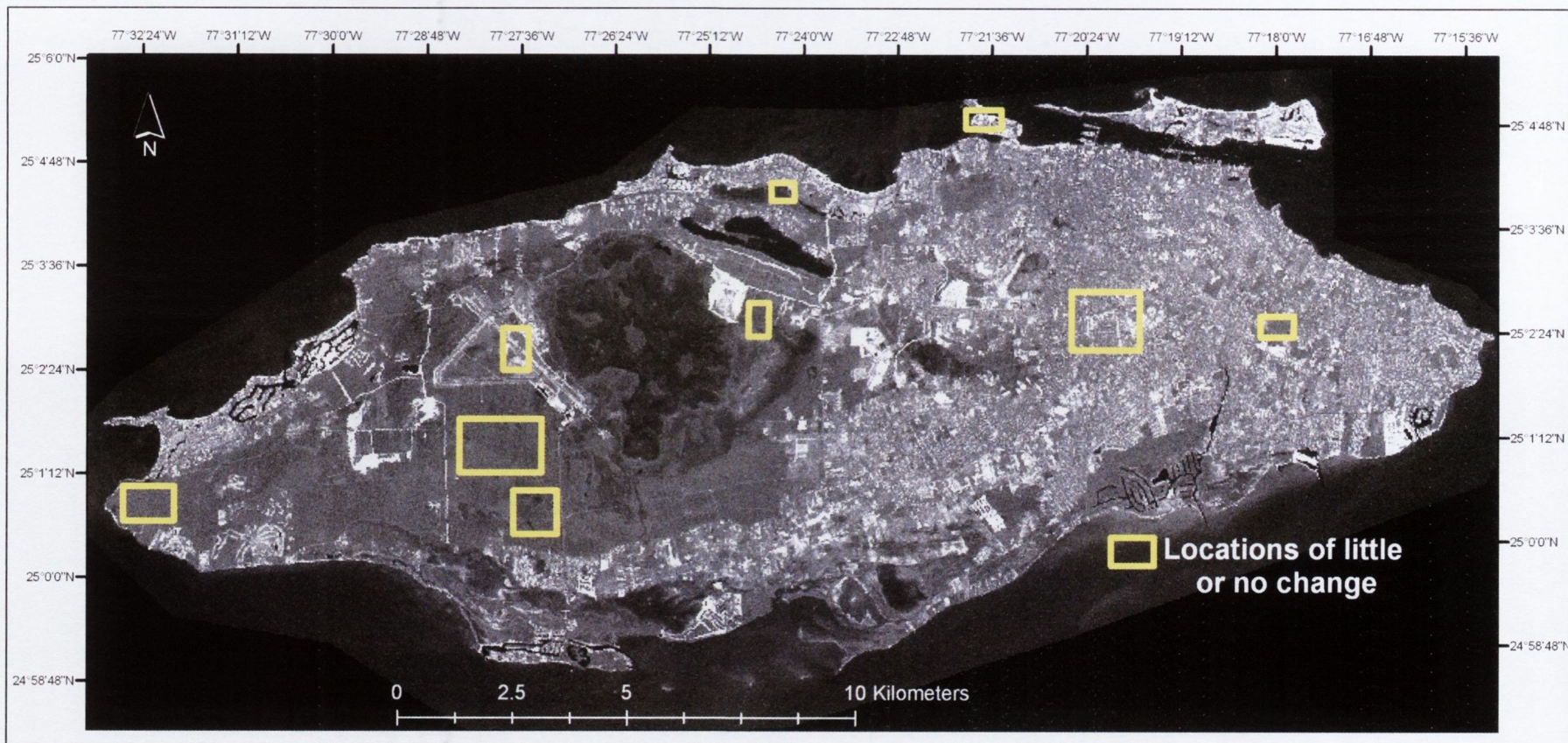


Figure 7.37. Locations of landscape areas exhibiting unchanged land cover characteristics.

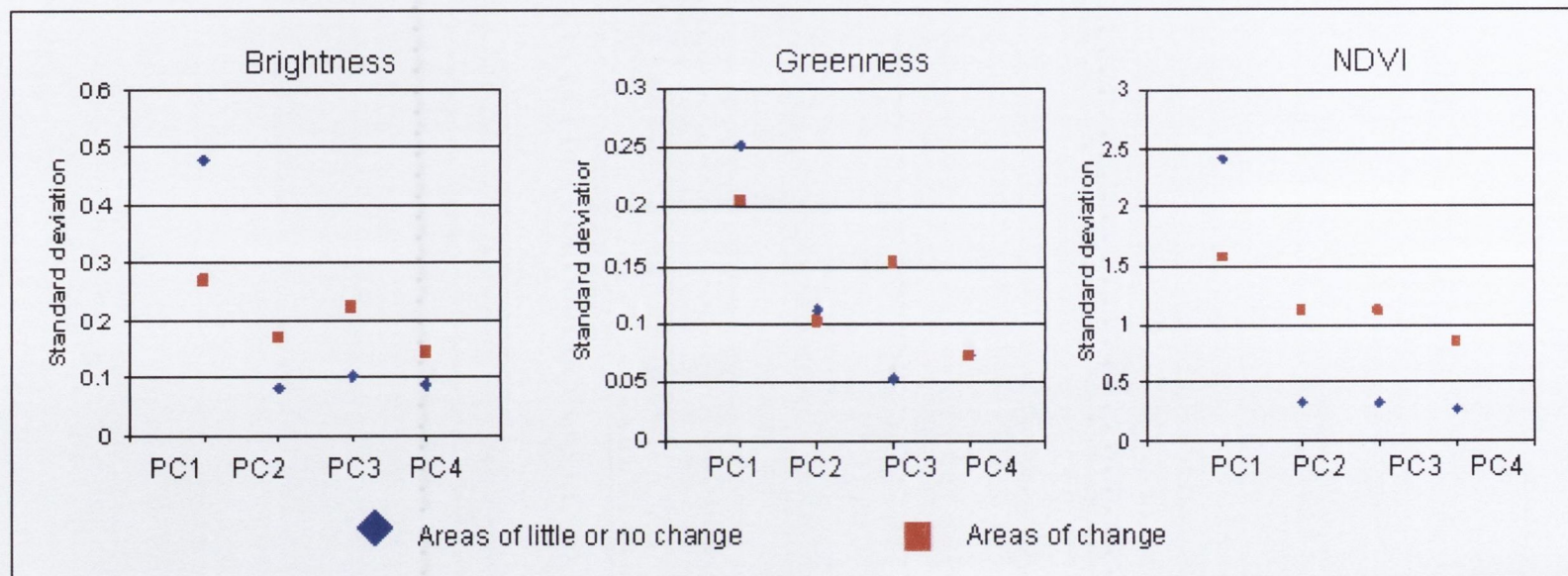


Figure 7.38. A comparison of aggregate standard deviation plots for locations exhibiting change and little or no change, generated from the brightness, greenness and NDVI PC images following multitemporal PCA on the 1973-1986-1999-2002 time series.

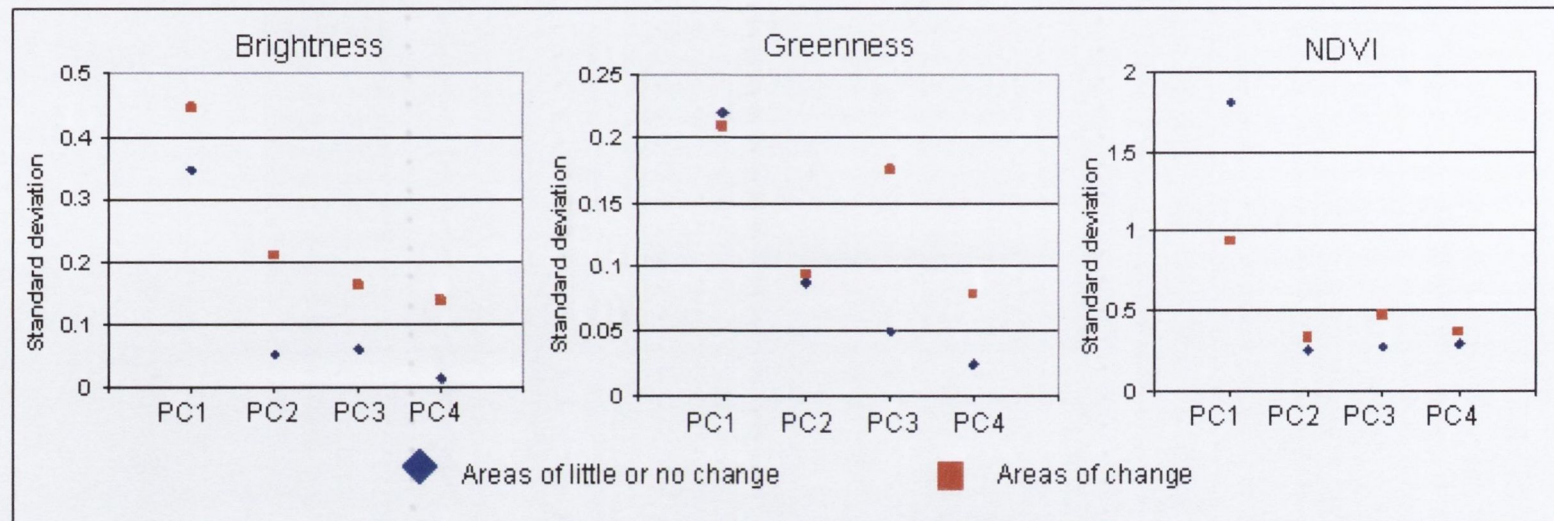


Figure 7.39. A comparison of aggregate standard deviation plots for locations exhibiting change and little or no change, generated from the brightness, greenness, NDVI PC images produced following multitemporal PCA on the 1985-1999-2001-2002 time series.

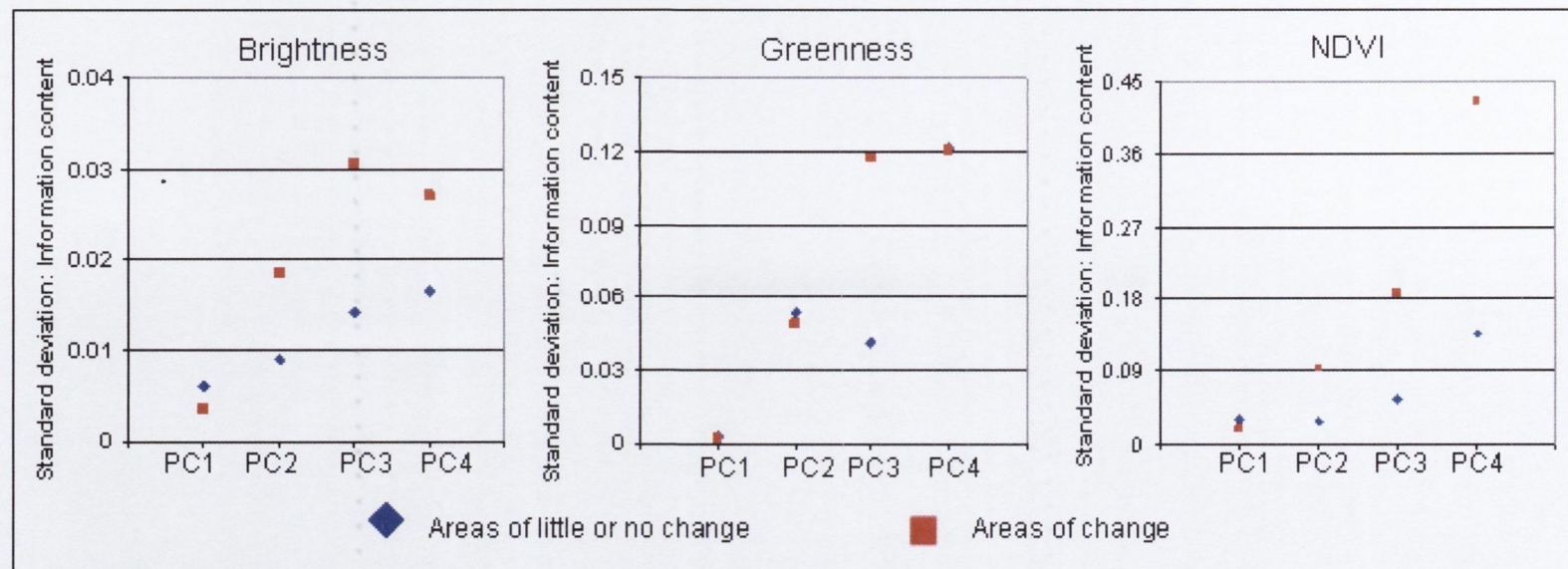


Figure 7.40. A comparison of the ratio of standard deviation to information content for locations exhibiting change and little or no change, generated from the brightness, greenness, NDVI PC images produced following multitemporal PCA on the 1973-1986-1999-2002 time series.

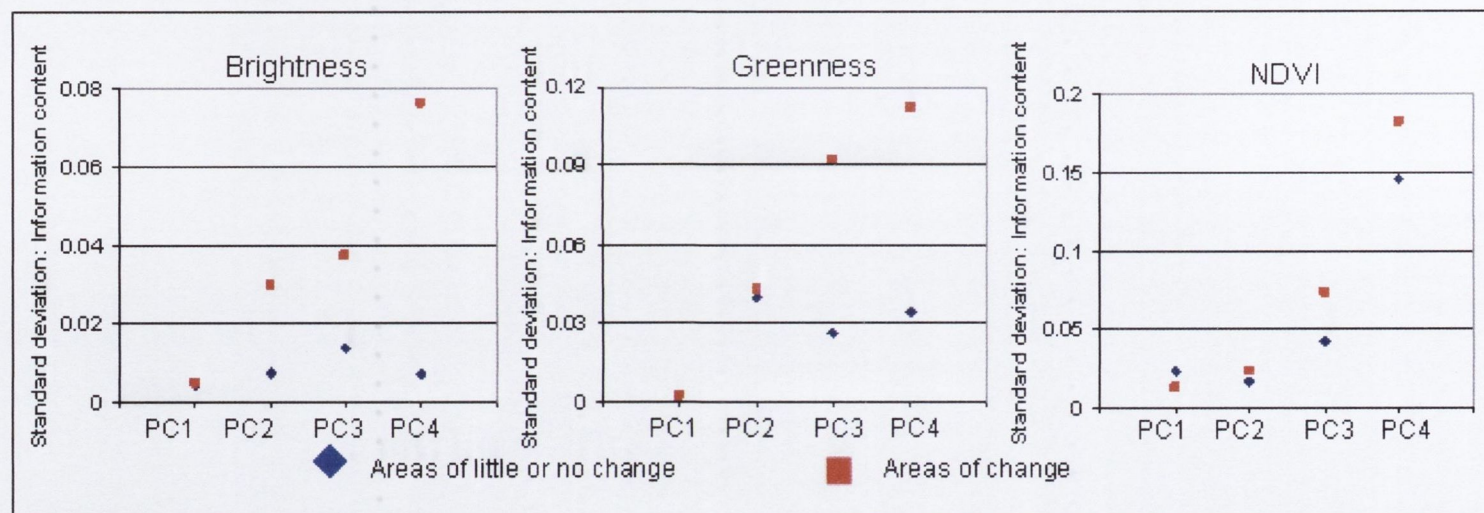


Figure 7.41. A comparison of the ratio of standard deviation to information content for locations exhibiting change and little or no change, generated from the brightness, greenness and NDVI PC images produced following multitemporal PCA on the 1985-1999-2001-2002 time series.

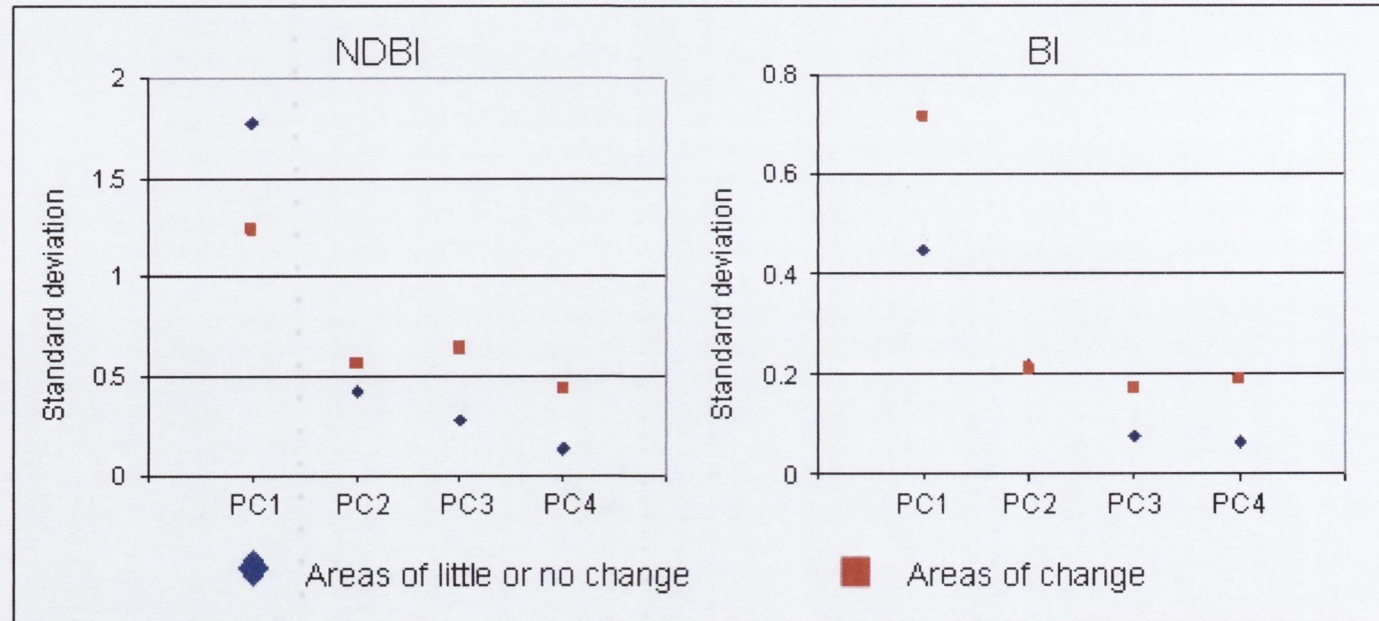


Figure 7.42. A comparison of aggregate standard deviation plots for locations exhibiting change and little or no change, generated from the NDBI and BI PC images produced following multitemporal PCA on the 1985-1999-2001-2002 time series.

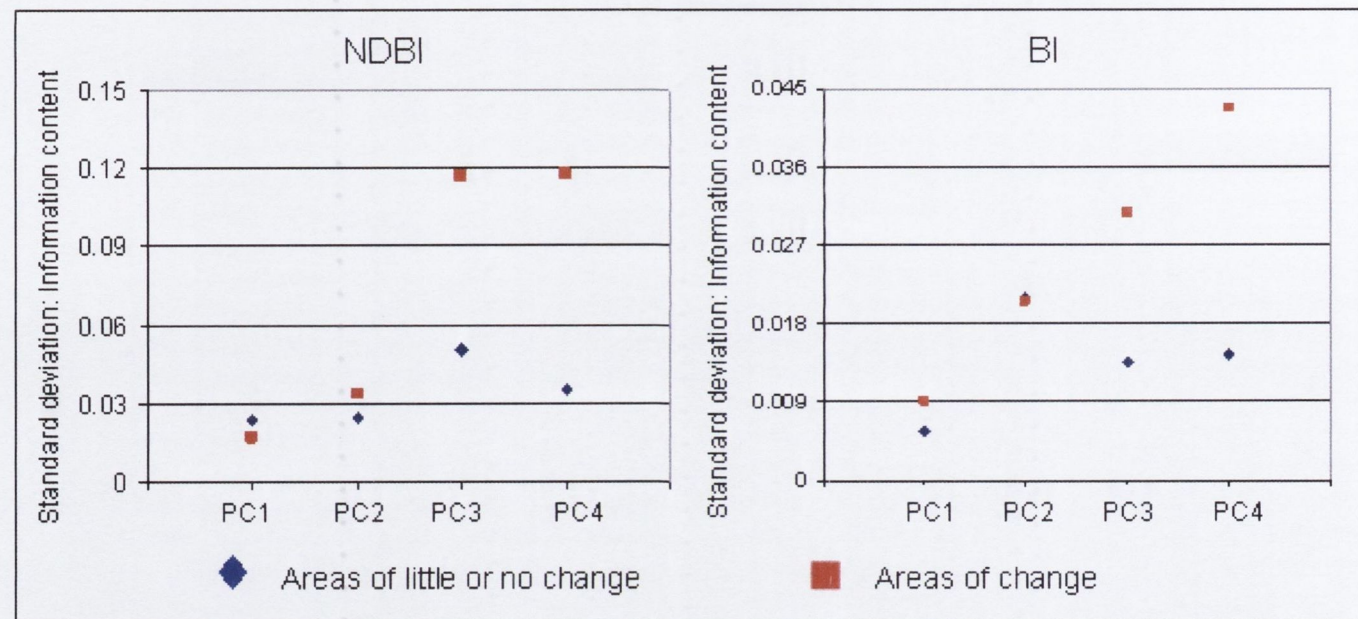


Figure 7.43. A comparison of the ratio of standard deviation to information content for locations exhibiting change and little or no change, generated from the NDBI and BI PC images produced following multitemporal PCA on the 1985-1999-2001-2002 time series.

Chapter 8 Tables and Figures

Table 8.1. Eigenvalues and cumulative variance expressed by each principal component produced following PCA on the Landsat ETM+ (2001 and 2002) and SPOT HRVIR (1999) datasets.

Sensor/Year	PC Number	Eigenvalue (variance)	Variance %	Accumulated Variance %
Landsat ETM+ 2001	PC1	14002.94	81.5	81.5
	PC2	2553.32	14.87	96.37
	PC3	325.08	1.89	98.26
	PC4	253.8	1.48	99.74
	PC5	26.83	0.16	99.9
	PC6	13.20	0.1	100
Landsat ETM+ 2002	PC1	9068.64	80.62	80.62
	PC2	1762.04	15.66	96.28
	PC3	244.22	2.17	98.45
	PC4	147.18	1.31	99.76
	PC5	16.75	0.15	99.91
	PC6	10.0	0.09	100
SPOT HRVIR 1999	PC1	27223.01	80.18	80.18
	PC2	5789.67	17.05	97.23
	PC3	585.99	1.73	98.96
	PC4	352.14	1.04	100

Table 8.2. Correlation between multispectral wavebands and a temperature images generated from the Landsat ETM+ 2001 and 2002 thermal wavebands (band 6).

	Landsat ETM+ waveband number					
	1	2	3	4	5	7
2001	0.882	0.835	0.753	0.745	0.690	0.662
2002	0.873	0.823	0.716	0.727	0.673	0.654

Table 8.3. Eigenvalues and cumulative variance expressed by each principal component produced following PCA on the Landsat ETM+ (2001 and 2002) datasets incorporating temperature.

Sensor/Year	PC Number	Eigenvalue (variance)	Variance %	Accumulated Variance %
Landsat ETM+ 2001	PC1	14555.41	81.24	81.24
	PC2	2570.04	14.34	95.58
	PC3	436.47	2.44	98.02
	PC4	262.65	1.47	99.49
	PC5	57.24	0.32	99.81
	PC6	25.20	0.14	99.95
	PC7			
Landsat ETM+ 2002	PC1	9584.94	80.13	80.13
	PC2	1784.59	14.92	95.05
	PC3	371.12	3.10	98.15
	PC4	147.25	1.23	99.38
	PC5	47.60	0.4	99.78
	PC6	16.55	0.14	99.92
	PC7	8.99	0.08	100

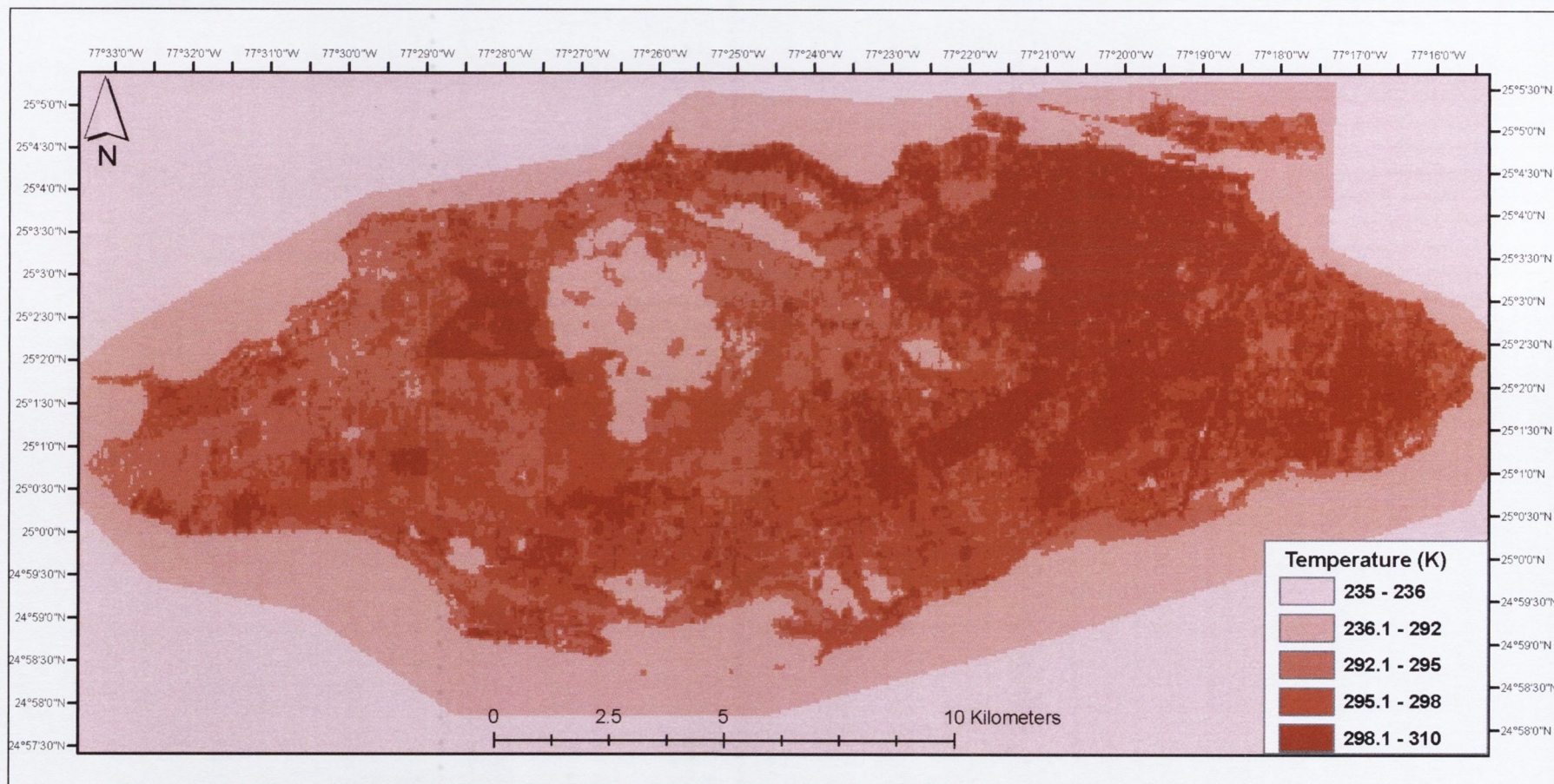


Figure 8.1. Temperature map of New Providence Island generated from Landsat ETM+ thermal band 6 imagery acquired in 2001.

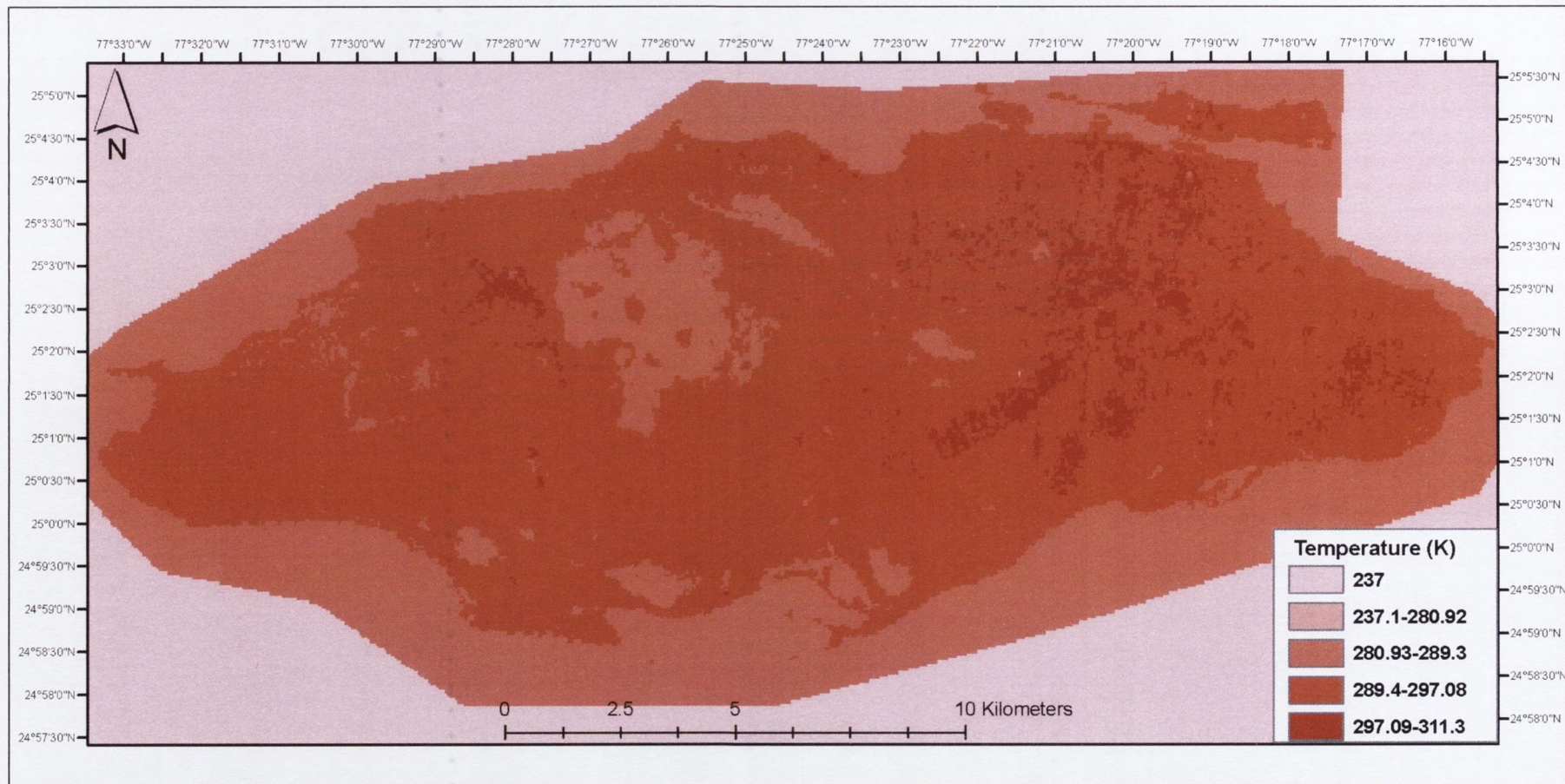


Figure 8.2. Temperature map of New Providence Island generated from Landsat ETM+ thermal band 6 imagery acquired in 2002.

Table 8.4. A comparison of temperature statistics derived from Landsat ETM+ 2001 and 2002 thermal band 6.

Acquisition date dd/mm/yy	Mean (K)	Standard deviation	Max (K)	Min (K)
16/05/01	294.24	4.02	308.73	286.46
16/03/02	294.85	17.85	311.34	280.93

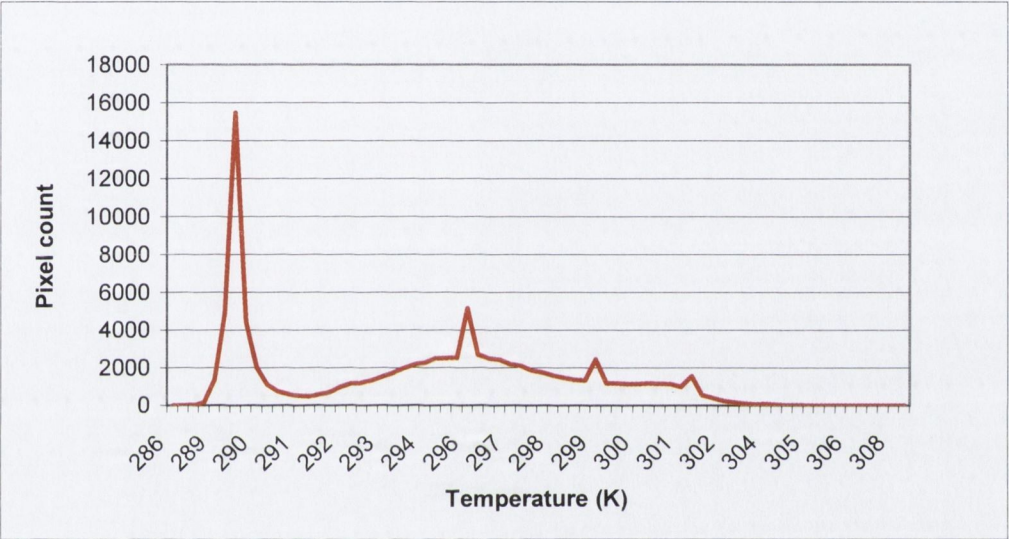


Figure 8.3. Frequency distribution of temperature values generated from the 2001 Landsat ETM+ thermal waveband.

Table 8.5. Distribution of temperature values generated from the 2002 Landsat ETM+ thermal waveband.

Temperature (K)	Pixel count
280.93	1
289.26	34484
297.09	57866
304.41	3892
311.34	3

Table 8.6. Results from a one-way ANOVA to test the significance of the relationship between land cover and temperature generated from Landsat ETM+ 2001 and 2002 data.

Land cover type	2001			2002		
	Count	Mean Temperature (K)	Standard deviation	Count	Mean Temperature (K)	Standard deviation
water	75677	259.59	4451.94	75803	260.37	4943.28
HAL	32450	297.58	137.44	32839	297.44	178.45
Sand	352	292.45	2280.5	350	291.03	38.47
Pine	16457	294.83	61.22	16967	296.69	13.39
DEF	8899	294.64	66.02	8767	296.03	9.84
Dense mangrove	1790	294.54	24.77	1548	294.44	70.66
Sparse mangrove	2227	295.54	30.35	1432	294.68	61.57
ANOVA TABLE						
	Sum of Squares	df	Variance	Sum of Squares	df	Variance
Between group variation	45976669.1319	6	7662778.1886	45416953.8203	6	7569492.3034
Within group variation	1502422895511.11223	137845	10899364.4710	1853362234917.029	137699	13459518.4781
F statistic	0.7030			0.5624		
p-value	0.647			0.7606		

Table 8.7. Comparison of the spectral sensitivity of a) Landsat ETM+ and b) SPOT HRVIR multispectral and panchromatic wavebands.

a)

Band number	Spectral Range (µm)	Spectral Region
1	0.45-0.515	Visible blue
2	0.525-0.605	Visible green
3	0.63-0.69	Visible red
4	0.75-0.90	Near infrared red
5	1.55-1.75	Shortwave infrared
6	10.4-12.5	Thermal
7	2.09-2.35	Mid Infrared
Panchromatic	0.52-0.90	Visible

b)

Band number	Spectral Range (µm)	Spectral Region
1	0.50-0.59	Visible green
2	0.61-0.68	Visible red
3	0.79-0.89	Near infrared
4	1.58-1.75	Shortwave infrared
Panchromatic	0.51-0.73	Visible

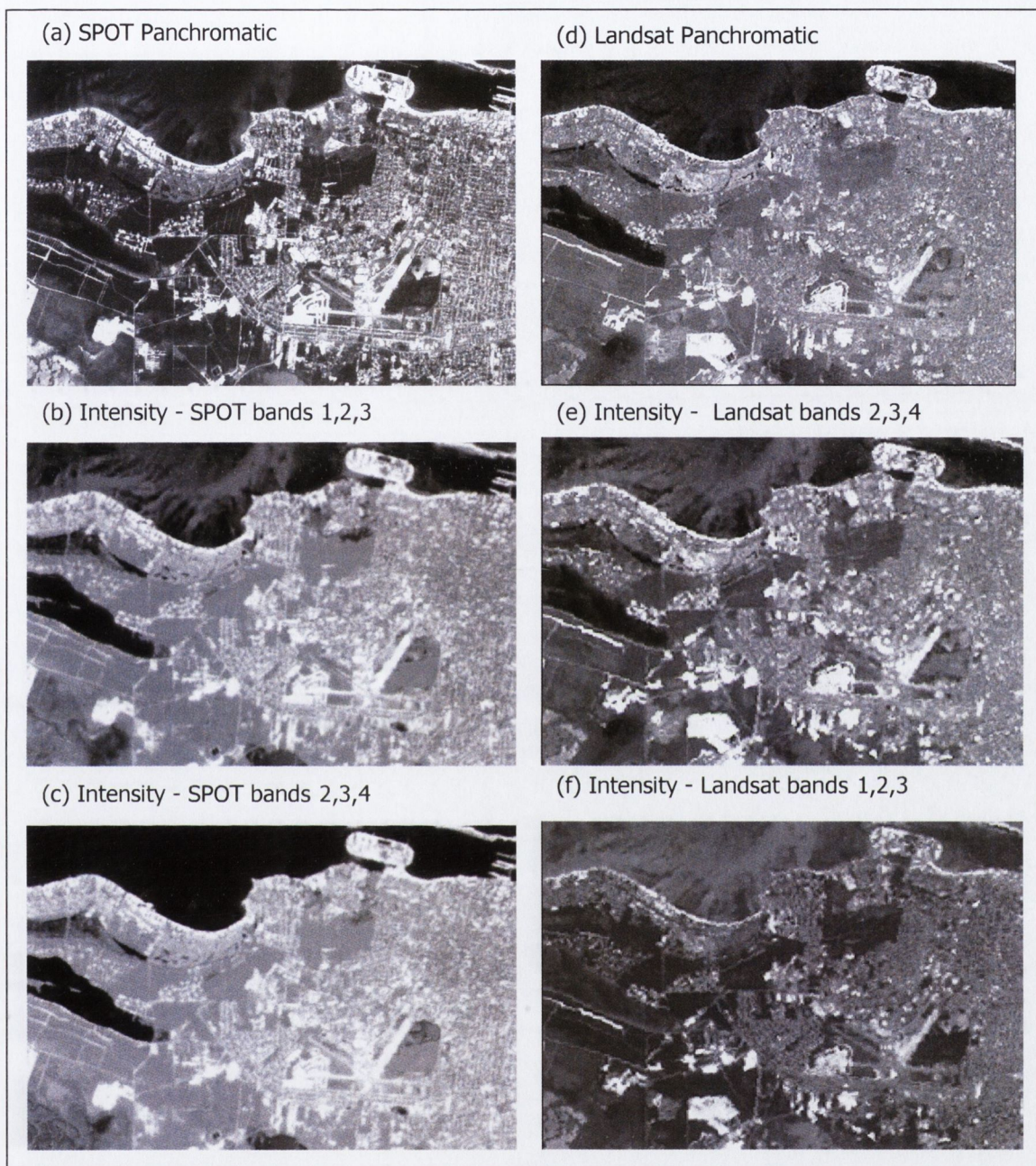


Figure 8.4. Visual comparison of a subset of SPOT HRVIR (1999) and Landsat ETM+ (2001) panchromatic images ((a) and (d)) and intensity images ((b), (c), (e) and (f)) using different combinations of the visible wavebands pertaining to each sensor.

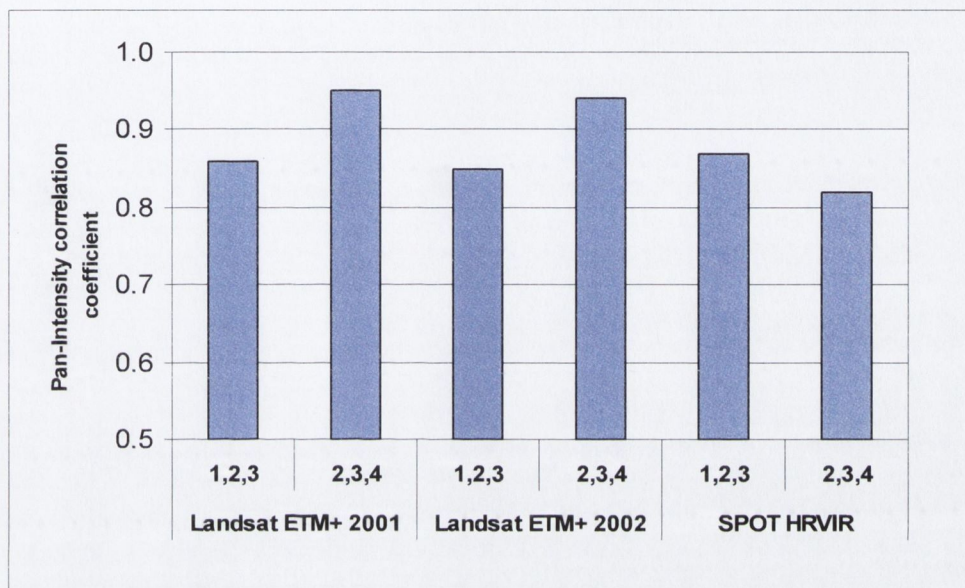


Figure 8.5. A comparison of the pan-intensity correlation coefficients derived from different waveband combinations of the original multispectral Landsat ETM+ and SPOT HRVIR images and their respective panchromatic wavebands.

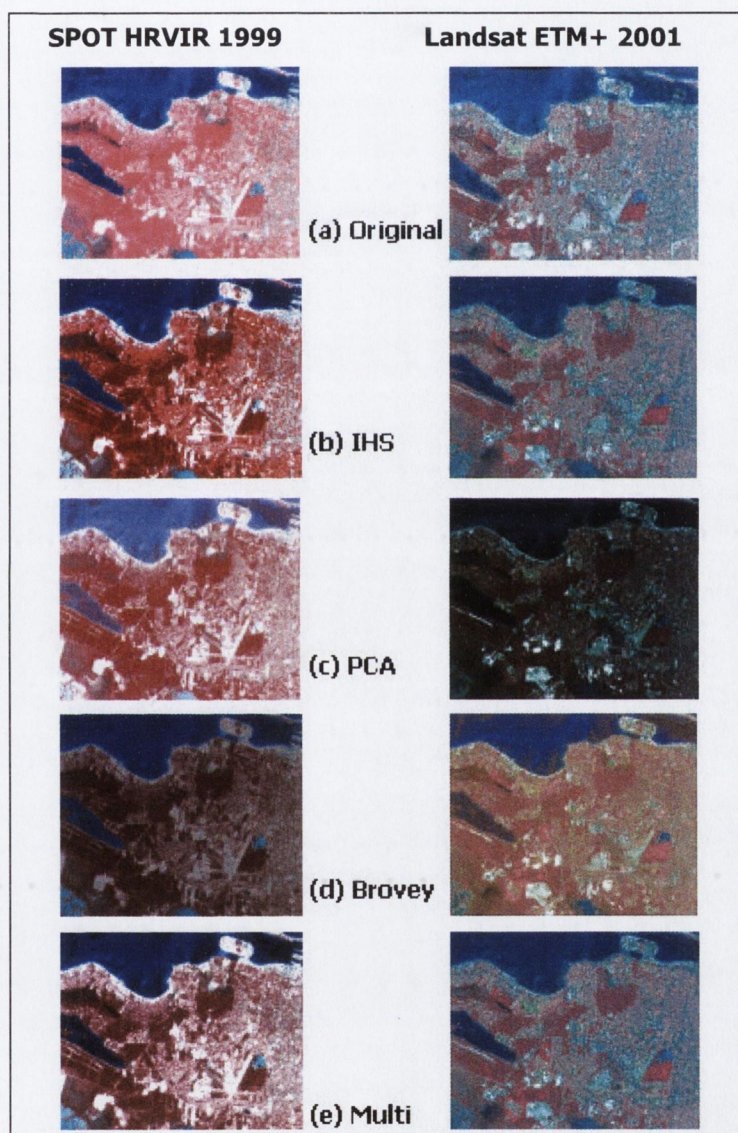


Figure 8.6. Inter-sensor comparison of the original and data fused SPOT HRVIR (1999) and Landsat ETM+ (2001) imagery following the application of IHS, PCA, Brovey and Multiplicative data fusion methods.

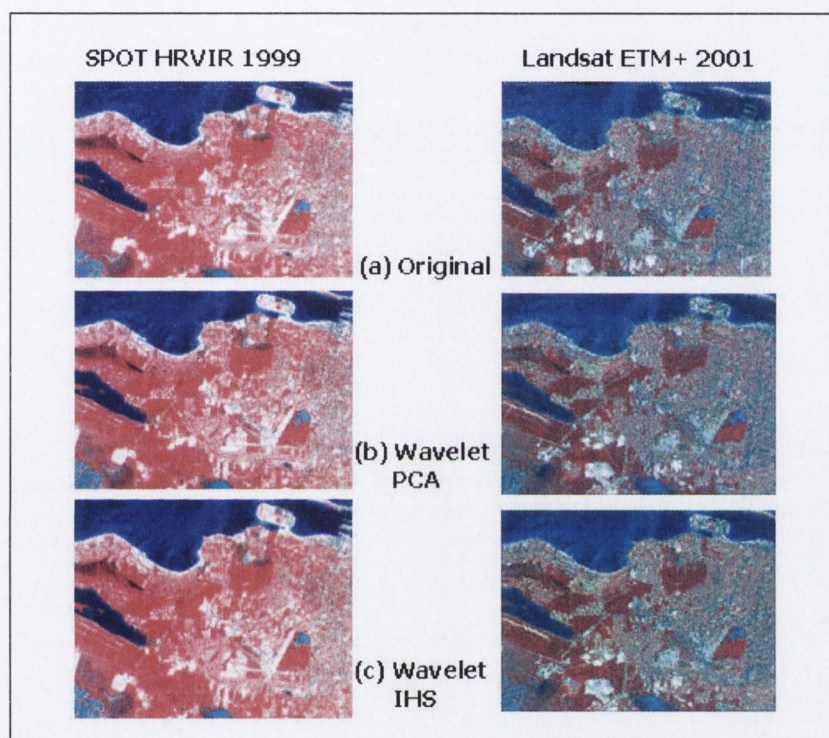


Figure 8.7. Inter-sensor comparison of the original and data fused SPOT HRVIR (1999) and Landsat ETM+ (2001) imagery following the application of Wavelet IHS and PCA data fusion methods.

Table 8.8. Correlation coefficients between original same sensor panchromatic image and intensity images generated for each of the data fused methods tested for the SPOT HRVIR and Landsat ETM+ datasets.

Sensor Year	Data Fusion Method					
	IHS	PCA	Brovey	Multi	Wavelet PCA	Wavelet IHS
SPOT HRVIR 1999	0.99	0.95	0.99	0.96	0.86	0.86
Landsat ETM+ 2001	0.99	0.99	0.99	0.91	0.95	0.95
Landsat ETM+ 2002	0.99	0.98	0.98	0.89	0.94	0.94

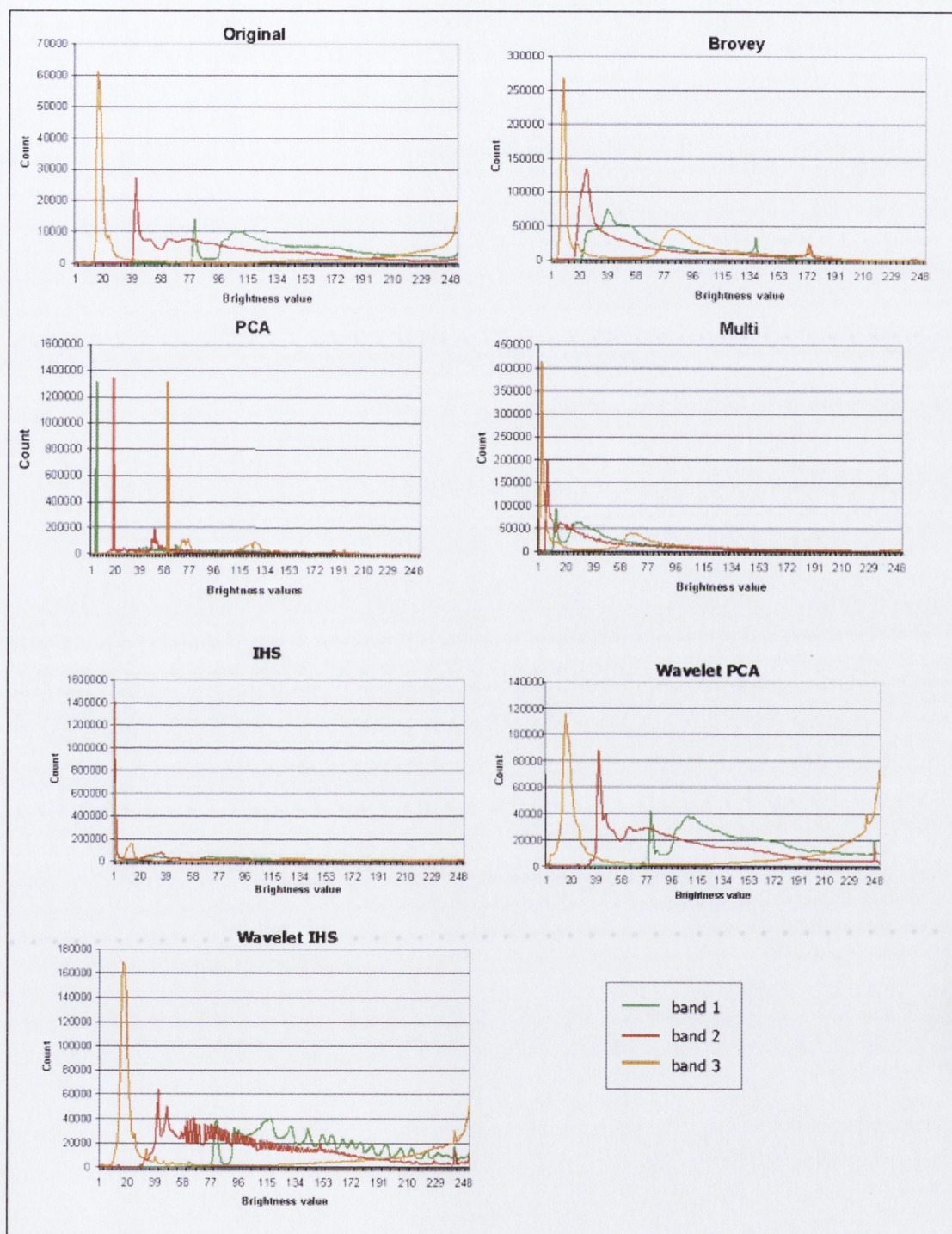


Figure 8.8. A comparison of the distribution of DN values across the 0-255 brightness range following data fusion of SPOT HRVIR 1999 imagery and the original multispectral wavebands 1, 2 and 3.

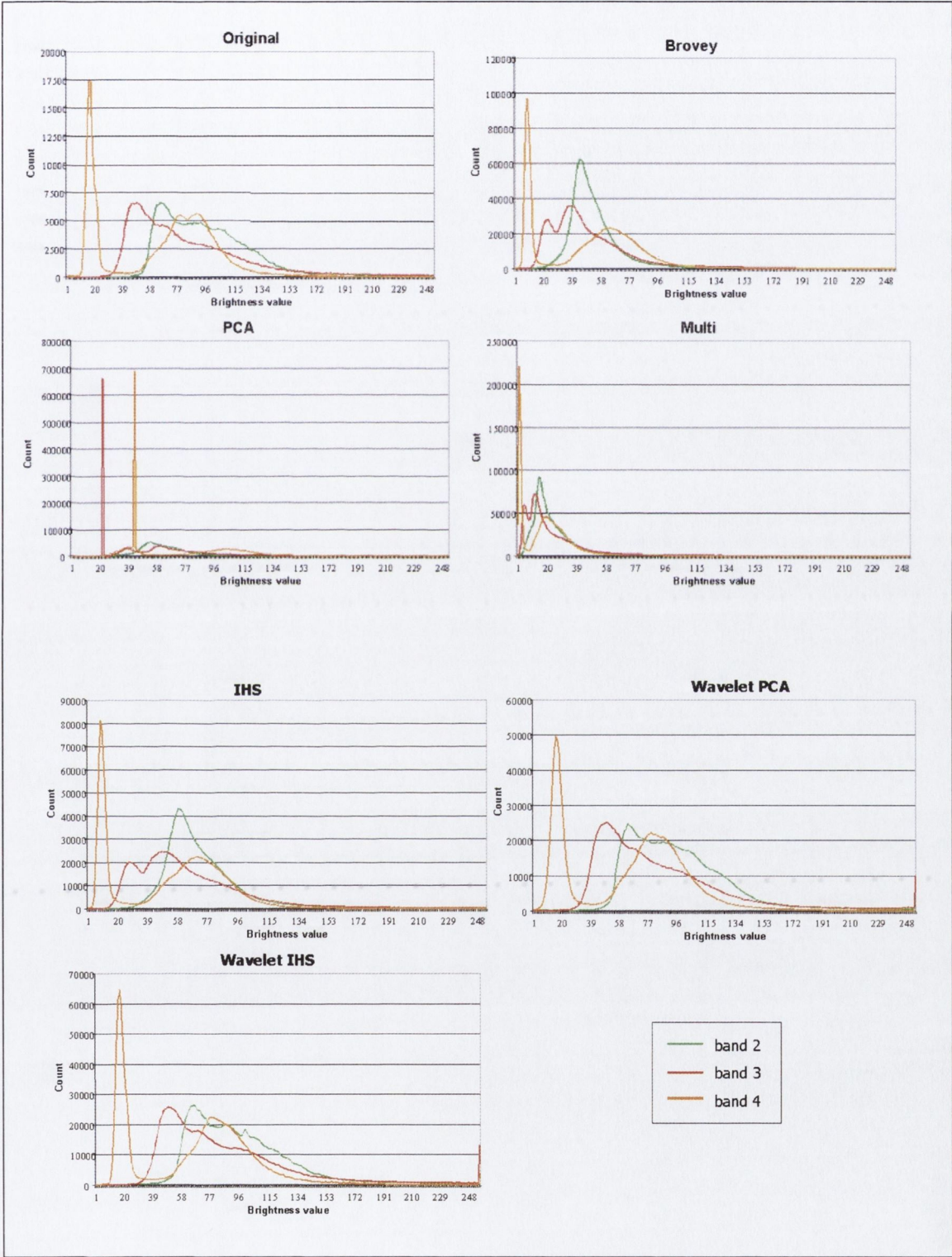


Figure 8.9. A comparison of the distribution of DN values across the 0-255 brightness range following data fusion of Landsat ETM+ 2001 imagery and the original multispectral wavebands 2, 3 and 4.

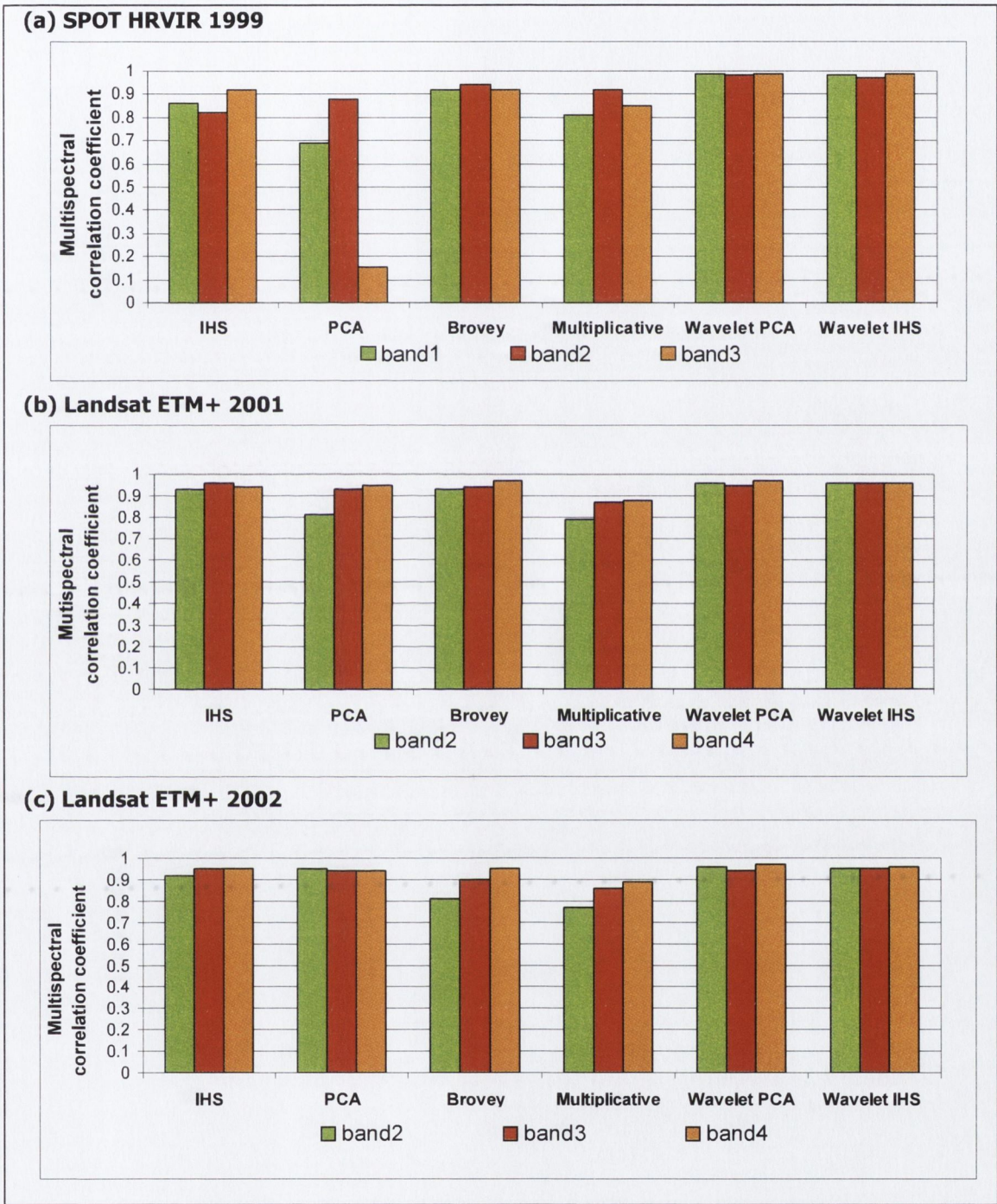


Figure 8.10. Correlation coefficients between original multispectral bands and IHS, PCA, Brovey, Multiplicative, Wavelet PCA and Wavelet IHS data fused imagery pertaining to (a) SPOT HRVIR 1999, (b) Landsat ETM+ 2001 and (c) Landsat ETM+ 2002 datasets.

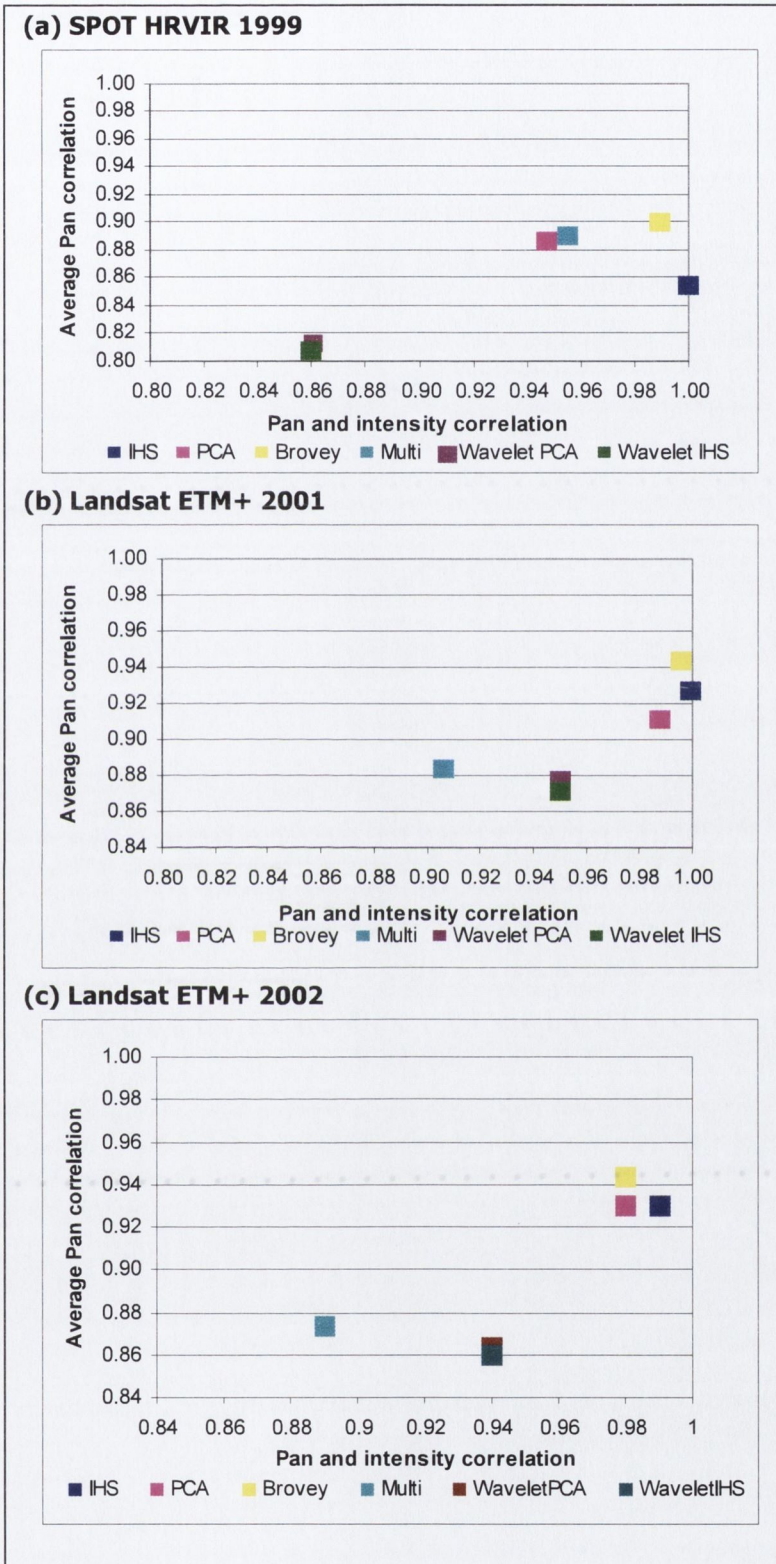


Figure 8.11. Preservation of spatial resolution regarding the similarity between the panchromatic and intensity images for the SPOT HRVIR (a) and Landsat ETM+ data (b) and (c) datasets.

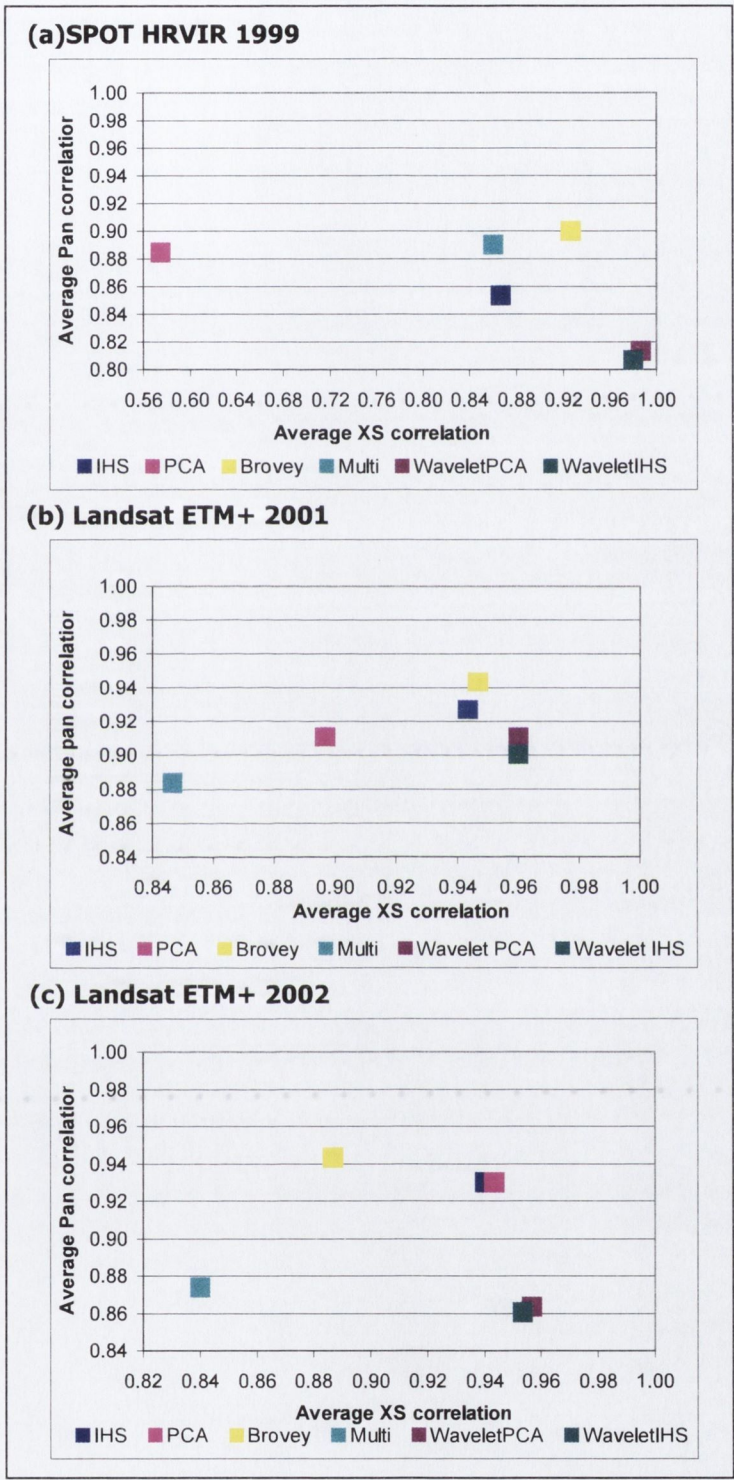


Figure 8.12. The relationship between spatial and spectral quality of the data fused images as defined by the correlation between the original multispectral and panchromatic imagery and the data fused imagery produced by each method of data fusion for the SPOT HRVIR (a) and Landsat ETM+ datasets (b) and (c).

Table 8.9. **Number of ground reference test points gathered in the field representing each land cover type used in the classification accuracy assessment.**

Land cover type	Number	Percent of total
Water	4	3.1
HAL	81	62.3
Sand	11	8.5
Pine	12	9.2
DEF	12	9.2
Dense mangrove	6	4.6
Sparse mangrove	4	3.1
Total	130	100

Table 8.10. Accuracy assessment of SPOT HRVIR 1999 land cover maps by each classification method tested.

	Classification Method															
	VISIR		PCA		IHS		PCA		Brovey		Multi		Wavelet PCA		Wavelet IHS	
Land Cover	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%
Water	100	44.44	100	44.44	100	33.33	100	30.77	100	33.33	100	36.36	100	23.53	100	28.57
HAL	92.59	89.29	88.89	86.75	87.65	85.54	88.89	88.89	90.12	86.90	87.65	88.75	85.19	94.52	82.72	81.71
Sand	9.09	100	9.09	100	9.09	100	9.09	100	0	0	18.18	100	9.09	16.67	18.18	40
Pine	100	50	75	36	58.33	35	66.67	34.78	58.33	33.33	58.33	30.43	75	56.25	41.67	45.45
DEF	33.33	80	41.67	71.43	50	66.67	41.67	71.43	58.33	70	50	66.67	75	53.86	58.33	53.85
Dense mangroves	50	60	50	60	16.67	100	16.67	50	0	0	16.67	25	58.33	53.85	16.67	100
Sparse mangroves	50	100	0	0	25	25	50	66.67	0	0	0	0	83.33	100	0	0
Overall Accuracy (%)	77.69		72.31		70		71.54		70		70		73.08		66.15	
Kappa	0.6099		0.5183		0.4799		0.4799		0.4752		0.49		0.5656		0.4185	
Variance	0.003399		0.003545		0.00353		0.003677		0.0034		0.0035		0.003117		0.0038	
Z value	10.46		8.71		8.077		7.91		8.09		8.23		10.13		6.79	
Spatial resolution	20m				10m											

Table 8.11. Accuracy assessment of Landsat ETM+ 2001 land cover maps by classification method (VISIR, PCA, Temp, TempPCA).

	Classification Method							
	VISIR		PCA		Temp		TempPCA	
Land Cover	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%
Water	100	44.44	100	66.67	100	36.36	100	66.67
HAL	91.36	91.36	87.65	85.54	85.19	86.25	87.65	83.53
Sand	27.27	100	9.09	100	9.09	50	9.09	100
Pine	100	60	100	57.14	100	52.17	91.67	45.83
DEF	75	90	75	90	66.67	88.89	66.67	88.89
Dense mangroves	66.67	100	66.67	100	16.67	100	50	100
Sparse mangroves	75	100	50	40	75	75	25	50
Overall Accuracy	83.85		79.23		75.38		76.15	
Kappa	0.7235		0.6391		0.5818		0.5784	
Variance Kappa	0.002751		0.003357		0.003326		0.003724	
Z value	13.97		11.03		10.09		9.479	

Table 8.12. Accuracy assessment of Landsat ETM+ 2002 land cover maps by classification method (VISIR, PCA, Temp, TempPCA).

	Image Classification Methods							
	VISIR		PCA		Temp		TempPCA	
Land Cover	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%
Water	100	50	100	44.44	100	40	100	57.14
HAL	95.06	83.70	88.89	82.76	93.83	84.44	80.25	80.25
Sand	9.09	100	9.09	100	9.09	100	-	-
Pine	91.67	64.71	91.67	55	91.67	55	91.67	34.38
DEF	58.33	100	58.33	87.5	50	100	33.33	100
Dense mangroves	33.33	66.67	33.33	66.67	16.67	100	33.33	66.67
Sparse mangroves	25	50	25	50	25	50	-	-
Overall Accuracy	79.23		75.38		76.92		66.15	
Kappa	0.6139		0.5595		0.5776		0.4192	
Variance	0.003714		0.003841		0.003931		0.003837	
Z value	10.07		9.03		9.21		6.78	

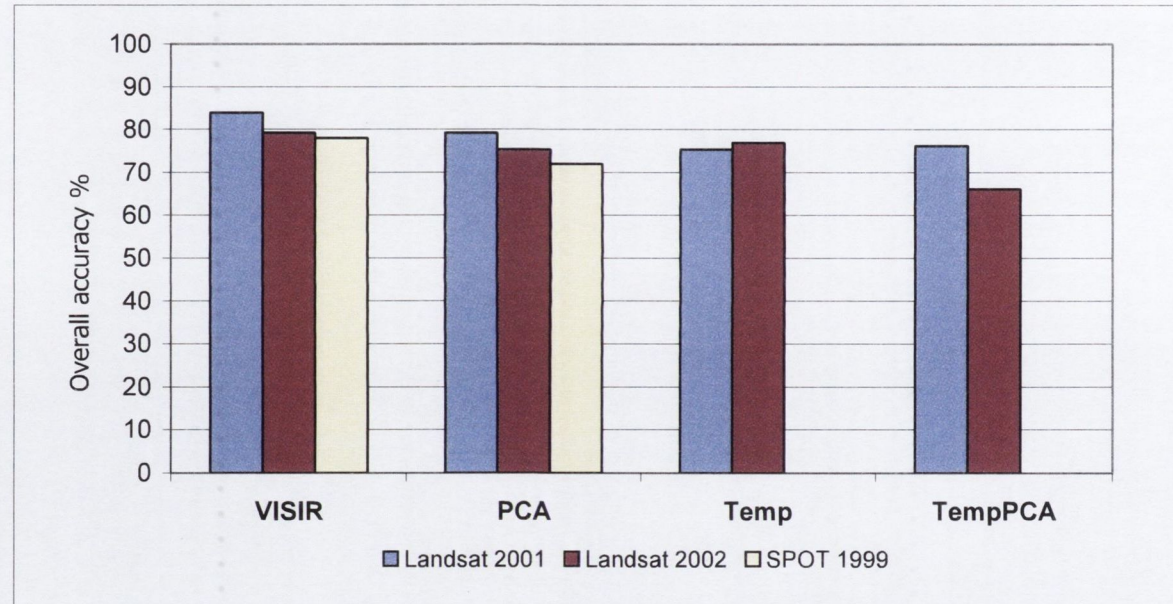


Figure 8.13. Inter-sensor comparison of overall land cover classification accuracies (%) for four classification methods VISIR, PCA, PCATemp and Temp generated from the Landsat ETM+ (2001 and 2002) and SPOT HRVIR (1999).

Table 8.13. Accuracy assessment of Landsat ETM+ 2001 data fusion land cover maps by classification method (IHS, panPCA, Brovey, Multi, Wavelet PCA and Wavelet IHS).

	Classification method											
	IHS		PCA		Brovey		Multi		Wavelet PCA		Wavelet IHS	
Land Cover	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%
Water	100	80	100	50	100	80	100	80	100	44.44	100	80
HAL	81.48	83.54	77.78	86.30	82.72	82.72	85.19	85.19	88.89	90.00	75.31	82.43
Sand	27.27	75	27.27	60	9.09	33.33	36.36	80	27.27	100	0	0
Pine	91.67	45.83	100	46.15	83.33	50	83.33	50	91.67	61.11	91.67	44
DEF	83.33	83.33	75	100	75	81.82	75	81.82	83.33	76.92	83.33	90.91
Dense mangroves	16.67	100	0	0	0	0	0	0	66.67	80	0	0
Sparse mangroves	0	0	0	0	25	10	25	12.5	50	100	25	6.67
Overall Accuracy	73.08		70		70.77		74.62		81.54		66.92	
Kappa	0.5440		0.5146		0.4997		0.5649		0.6861		0.4662	
Variance	0.003652		0.003415		0.003767		0.003602		0.002976		0.003537	
Z value	9.00		8.81		8.14		9.41		12.58		7.84	

Table 8.14. Accuracy assessment of Landsat ETM+ 2002 data fusion land cover maps by classification method (IHS, panPCA, Brovey, Multi, Wavelet PCA and Wavelet IHS).

	Classification method											
	IHS		PCA		Brovey		Multi		Wavelet PCA		Wavelet IHS	
Land Cover	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%
Water	100	40	100	40	100	44.44	100	57.14	100	50	100	66.67
HAL	87.65	85.54	85.19	88.46	88.89	82.76	88.89	84.71	86.42	87.50	82.72	82.72
Sand	9.09	100	9.09	100	9.09	100	9.09	100	9.09	100	18.18	100
Pine	83.33	40	100	40	75	37.5	91.67	45.83	66.67	36.36	91.67	36.67
DEF	58.33	77.78	58.33	87.50	50	85.71	66.67	88.89	58.33	63.64	66.67	100
Dense mangroves	16.67	100	0	0	16.67	100	16.67	50	66.67	57.14	16.67	50
Sparse mangroves	25	100	25	50	0	0	25	50	25	100	0	0
Overall Accuracy	73.08		72.31		71.54		75.38		73.08		71.54	
Kappa	0.5313		0.5348		0.4896		0.5649		0.5420		0.5102	
Variance	0.003714		0.003467		0.003993		0.003727		0.00353		0.003792	
Z value	8.72		9.08		7.75		9.25		9.12		8.29	

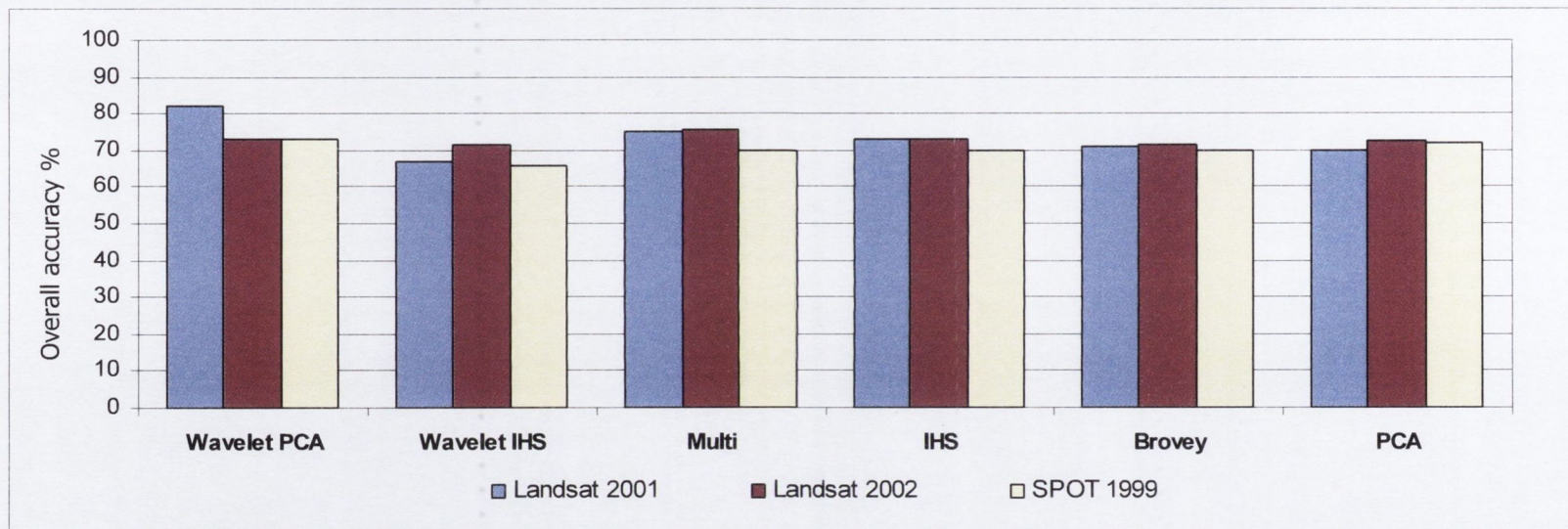


Figure 8.14. Inter-sensor comparison of overall land cover classification accuracy values (%) for six data fusion classification methods generated from the Landsat ETM+ (2001 and 2002) and SPOT HRVIR (1999).

Table 8.15. A comparison of accuracy assessment results by land cover classification method of the original (no filter) and majority filtered land cover maps generated from SPOT HRVR 1999.

Classification method	No filter		3x3 Majority filter	
	Overall Accuracy (%)	Kappa	Overall Accuracy (%)	Kappa
VISIR	77.69	0.6099	76.15	0.5892
PCA	72.31	0.5183	69.23	0.4609
Wavelet PCA	73.08	0.5656	73.85	0.5750
PCA	71.54	0.5137	71.54	0.5072
Multi	70	0.49	70	0.49
IHS	70	0.4799	69.23	0.4661
Brovey	70	0.4752	69.23	0.4578
Wavelet IHS	66.15	0.4185	68.46	0.4419

Table 8.16. A comparison of accuracy assessment results by land cover classification method of the original (no filter) and majority filtered land cover maps generated from Landsat ETM+ 2001.

	No filter		3x3 Majority filter	
	Overall Accuracy (%)	Kappa	Overall Accuracy (%)	Kappa
VISIR	83.85	0.7235	81.54	0.6886
PCA	79.23	0.6391	80.00	0.6503
PCATemp	76.15	0.5784	75.38	0.5647
Temp	75.38	0.5818	73.08	0.5488
Wavelet PCA	81.54	0.6861	81.54	0.6840
Multi	74.62	0.5649	75.38	0.5751
IHS	73.08	0.5440	73.85	0.5572
Brovey	70.77	0.4997	70.77	0.4921
PCA	70	0.5146	70	0.5141
Wavelet IHS	66.92	0.4622	67.69	0.4644

Table 8.17. A comparison of accuracy assessment results by land cover classification method of the original (no filter) and majority filtered land cover maps generated from Landsat ETM+ 2002.

	No filter		3x3 Majority filter	
	Overall Accuracy (%)	Kappa	Overall Accuracy (%)	Kappa
VISIR	79.23	0.6139	76.92	0.5836
PCA	75.38	0.5595	73.85	0.5485
Temp	76.92	0.5776	73.08	0.5284
PCATemp	66.15	0.4192	64.62	0.4053
Multi	75.38	0.5649	74.62	0.5545
Wavelet PCA	73.08	0.5420	74.62	0.5646
IHS	73.08	0.5313	72.31	0.5106
PCA	72.31	0.5348	72.31	0.5316
Wavelet IHS	71.54	0.5102	71.54	0.5060
Brovey	71.54	0.4896	71.54	0.4768

Table 8.18. Accuracy assessment results detailing the improvement in classification accuracy following the application of a 3x3 majority filter for a selection of the SPOT HRVIR and Landsat ETM+ datasets.

	Classification method													
	SPOT HRVIR 1999				Landsat ETM+ 2001								Landsat ETM+ 2002	
	Wavelet IHS		Wavelet PCA		PCA		Multi		IHS		Wavelet IHS		Wavelet PCA	
	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%
Land cover	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%
Water	100	23.53	100	28.57	100	57.14	100	80	100	80	100	57.14	100	50
HAL	86.42	94.59	86.42	81.40	90.12	86.90	86.42	85.37	82.72	84.81	77.78	82.89	87.65	87.65
Sand	9.09	20	18.18	66.67	9.09	100	36.36	80.00	27.27	75	0	0	9.09	100
Pine	83.33	55.56	41.67	50	91.67	55	83.33	52.63	91.67	44	91.67	40.74	83.33	41.67
DEF	58.33	58.33	58.33	53.85	66.67	88.89	75	81.82	83.33	90.91	75	90	58.33	70
Dense mangroves	66.67	100	16.67	100	66.67	100	0	0	0	0	0	0	50	60
Sparse mangroves	0	0	0	0	75	60	25	12.5	25	16.67	25	10	25	100
Overall Accuracy	73.85		68.46		80.00		75.38		73.85		67.49		74.62	
Kappa	0.6846		0.4419		0.6503		0.5751		0.5751		0.4644		0.5646	

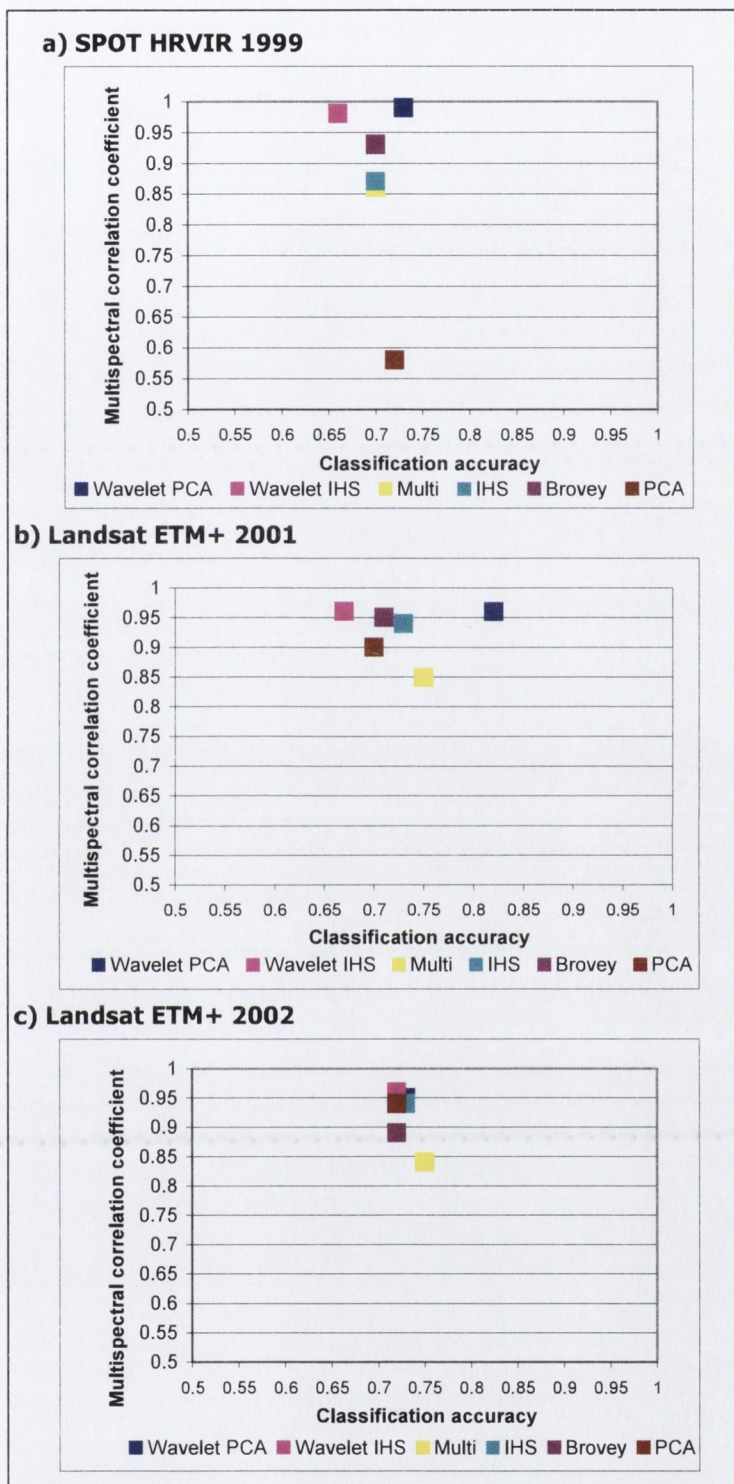


Figure 8.15. The relationship between the preservation of spectral quality described by the correlation between the original multispectral and data fused imagery and classification accuracy.

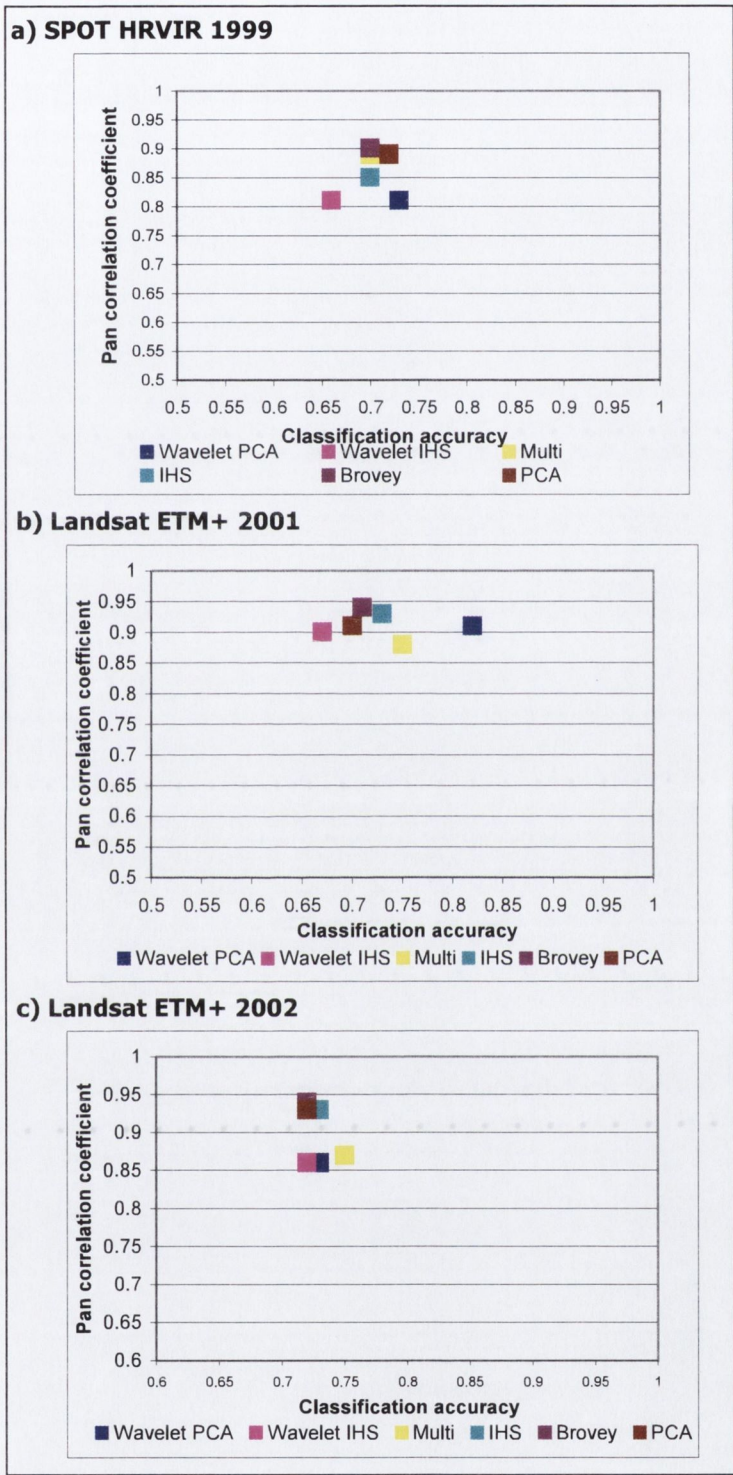


Figure 8.16. The relationship between preservation of spectral quality described by correlation between the original panchromatic and data fused imagery and classification accuracy.

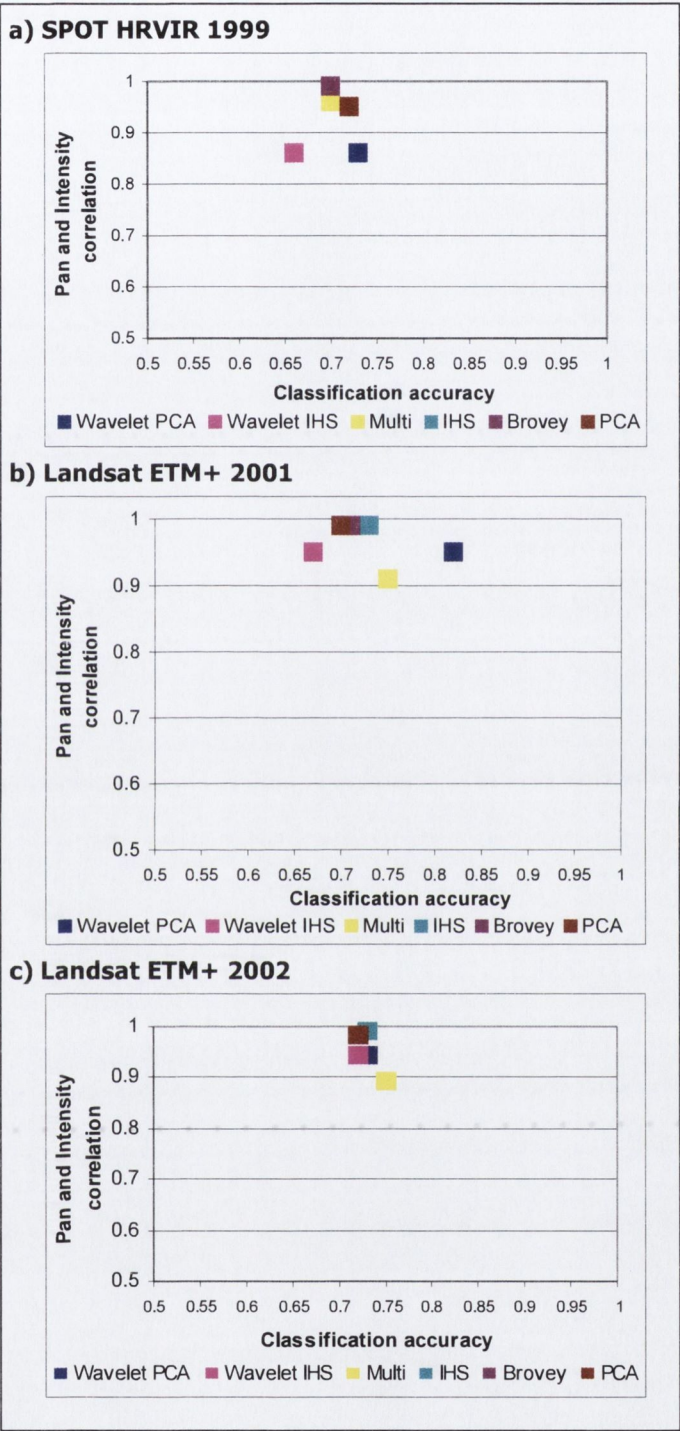


Figure 8.17. The relationship between the preservation of spatial quality described by the correlation between the original panchromatic and data fused intensity imagery and classification accuracy.

Table 8.19. Comparison of land cover type area for each year in the time series estimated from the land cover classification maps.

Satellite Sensor	Year	% HAL	% Sand	% Pine	% DEF	% Dense mangrove	% Sparse mangrove	% Vegetation*	% Wetland**
Landsat MSS	1973	38.15	0.94	34.37	19.11	4.78	2.65	53.48	7.43
SPOT HRV	1986	43.18	0.54	34.0	17.93	2.32	2.03	51.92	4.36
SPOT HRVIR	1999	52.08	0.56	26.46	16.13	2.44	2.33	42.59	4.77
Landsat ETM+	2001	52.18	0.59	26.42	14.38	2.82	3.61	40.80	6.46
Landsat ETM+	2002	52.77	0.56	27.55	14.36	2.44	2.3	41.91	4.74

* combination def and pine values

** combination of dense and sparse mangrove

Table 8.20. Summary of land cover classification area statistics for 1973, 1986, 1999, 2001, 2002 and relative change percentages values between 1973-2002.

Land cover	1973		1986		1999		2001		2002		Relative change
	Area (000 Ha)	%	Area (000 Ha)	%	Area (000 Ha)	%	Area (000 Ha)	%	Area (000 Ha)	%	1973-2002 (%)
hal	7.8	38.15	8.65	43.18	10.46	52.08	10.54	52.18	10.64	52.77	+36.28
sand	0.19	0.94	0.11	0.54	0.11	0.56	0.12	0.59	0.11	0.56	-42.11
pine	7.03	34.37	6.81	34	5.31	26.46	5.34	26.42	5.55	27.55	-21.05
def	3.91	19.11	3.59	17.93	3.24	16.13	2.9	14.38	2.89	14.36	-26.09
denman	0.98	4.78	0.47	2.32	0.49	2.44	0.57	2.82	0.49	2.44	-50.00
spman	0.54	2.66	0.41	2.03	0.47	2.33	0.73	3.61	0.47	2.32	-12.96
vegetation	10.94	53.48	10.4	51.93	8.55	41.91	8.24	40.8	8.44	42.06	-22.85
wetlands	1.52	7.44	0.88	4.35	0.96	4.76	1.3	6.43	0.96	4.41	-36.84

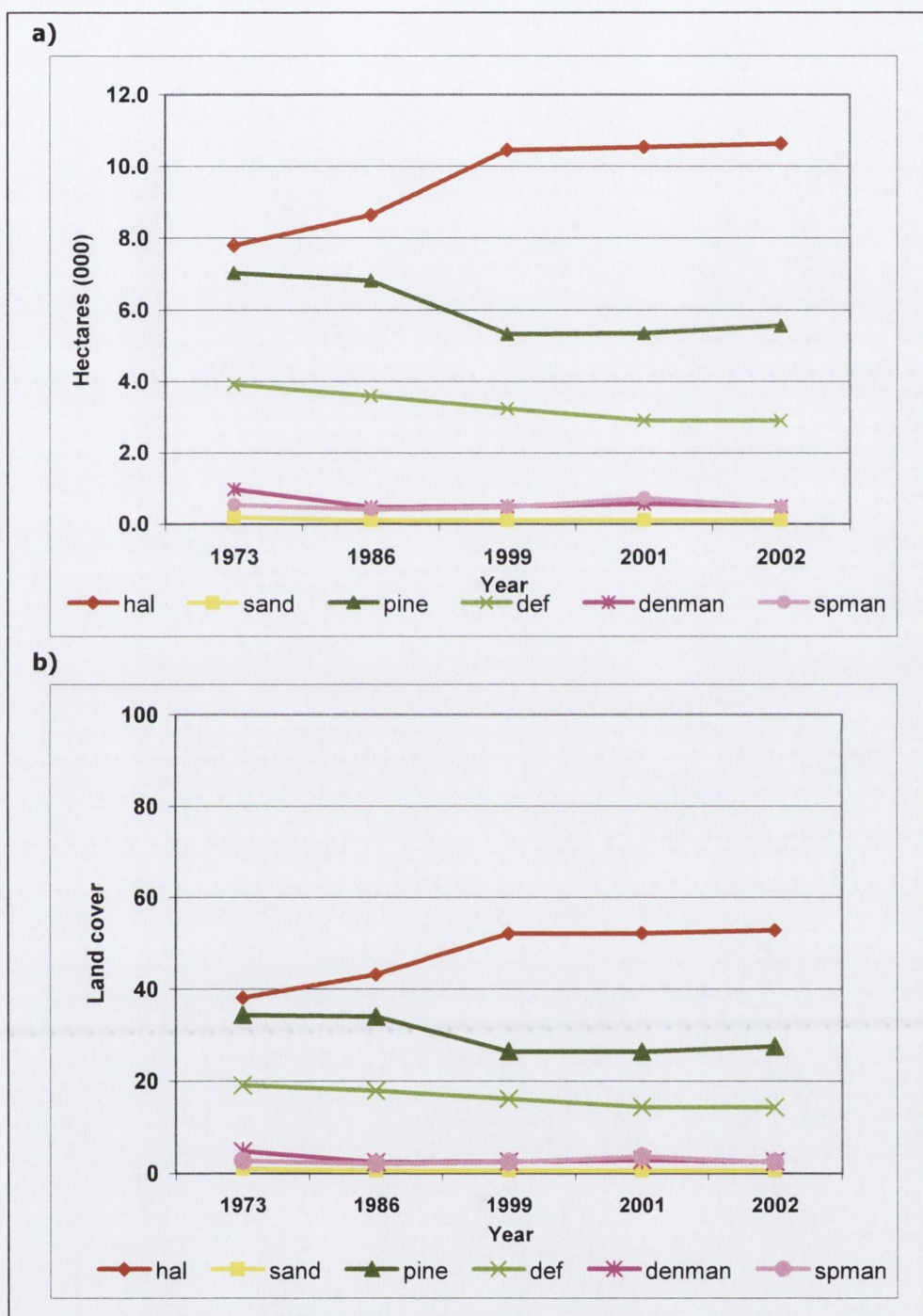


Figure 8.18. Land cover type area change from 1973-2002 estimated from the land cover classification. Land cover area is expressed (a) in hectares (000) and (b) as a percentage of total land cover for each map year.

Table 8.21. Matrices of land cover change area values in hectares (000) estimated from the land cover classification between 1973 and 2002.

a) 1973-1986								
1986								
1973	water	HAL	Sand	Pine	DEF	Denman	Spman	Total 1973
water	23.88	0.10	0.03	0.04	0.01	0.04	0.04	24.14
HAL	0.28	5.18	0.03	1.47	0.92	0.04	0.04	7.94
Sand	0.21	0.04	0.03	0.01	0.01	0.00	0.01	0.30
Pine	0.10	1.43	0.01	4.24	1.06	0.15	0.08	7.08
DEF	0.04	1.71	0.01	0.59	1.57	0.01	0.00	3.93
Denman	0.31	0.13	0.01	0.37	0.02	0.17	0.13	1.14
Spman	0.36	0.08	0.00	0.10	0.01	0.07	0.11	0.73
Total 1986	25.18	8.67	0.11	6.82	3.60	0.47	0.41	45.26
b) 1986-1999								
1999								
1986	water	HAL	Sand	Pine	DEF	Denman	Spman	Total 1986
water	24.58	0.09	0.02	0.04	0.00	0.08	0.08	24.90
HAL	0.09	6.88	0.02	0.56	1.00	0.03	0.07	8.56
Sand	0.02	0.01	0.06	0.00	0.00	0.00	0.00	0.08
Pine	0.04	1.92	0.00	4.03	0.62	0.11	0.09	6.77
DEF	0.00	1.47	0.00	0.50	1.60	0.00	0.00	3.59
Denman	0.03	0.04	0.00	0.12	0.00	0.21	0.06	0.44
Spman	0.05	0.05	0.00	0.06	0.00	0.06	0.19	0.36
Total 1999	24.82	10.37	0.09	5.27	3.24	0.41	0.42	44.70
c) 1999-2001								
2001								
1999	water	HAL	Sand	Pine	DEF	Denman	Spman	Total 1999
water	22.44	0.10	0.04	0.01	0.01	0.04	0.09	22.74
HAL	0.09	8.52	0.01	0.75	0.95	0.03	0.10	10.46
Sand	0.02	0.03	0.06	0.00	0.00	0.00	0.01	0.11
Pine	0.04	0.69	0.00	3.96	0.30	0.20	0.13	5.31
DEF	0.01	1.10	0.00	0.48	1.64	0.01	0.01	3.24
Denman	0.05	0.03	0.00	0.08	0.00	0.23	0.10	0.49
Spman	0.01	0.06	0.00	0.07	0.00	0.07	0.25	0.47
Total 2001	22.66	10.54	0.12	5.34	2.90	0.57	0.69	42.82
d) 2001-2002								
2002								
	water	HAL	Sand	Pine	DEF	Denman	Spman	Total 2001
water	24.36	0.07	0.04	0.02	0.00	0.04	0.02	24.55
HAL	0.06	9.17	0.00	0.65	0.60	0.02	0.04	10.54
Sand	0.03	0.02	0.07	0.00	0.00	0.00	0.00	0.12
Pine	0.01	0.51	0.00	4.32	0.39	0.07	0.04	5.34
DEF	0.00	0.73	0.00	0.28	1.89	0.00	0.00	2.90
Denman	0.05	0.03	0.00	0.18	0.00	0.26	0.04	0.57
Spman	0.09	0.09	0.00	0.11	0.00	0.11	0.33	0.73
Total 2002	24.58	10.56	0.08	5.54	2.89	0.46	0.45	44.56
e) 1973-2002								
2002								
	water	HAL	Sand	Pine	DEF	Denman	Spman	Total 1973
water	22.15	0.15	0.04	0.04	0.01	0.06	0.04	22.48
HAL	0.13	5.69	0.02	1.05	0.77	0.04	0.10	7.80
Sand	0.09	0.05	0.03	0.00	0.01	0.00	0.01	0.19
Pine	0.07	2.26	0.01	3.61	0.86	0.13	0.09	7.03
DEF	0.03	2.22	0.01	0.43	1.21	0.00	0.00	3.91
Denman	0.13	0.19	0.00	0.34	0.03	0.18	0.12	0.98
Spman	0.14	0.10	0.00	0.09	0.01	0.09	0.11	0.54
Total 2002	22.73	10.66	0.11	5.56	2.90	0.50	0.47	42.93

Table 8.22. Total land mass and water body area values in hectares (000) as determined from the land cover classification maps pertaining to 1973, 1986, 1986, 1999, 2001 and 2002.

Year	Scene dimensions		Hectares (000)		
	No. columns	No. rows	Total land mass	Total water	Ratio of land to water
1973	1153	509	20.451	27.218	0.751
1986	1127	515	20.038	27.105	0.739
1999	1129	514	20.087	27.048	0.743
2001	1143	482	20.203	24.546	0.823
2002	1143	482	20.159	24.582	0.820

Table 8.23. Conversion of pine, DEF, sparse and dense mangrove land cover classes to HAL between 1973-2002 estimated from the land cover classification.

Change type from classification	Number of pixels	Percent contribution to HAL 2002
Pine to HAL	27841	21.2
DEF to HAL	27327	20.8
Dense mangrove to HAL	2279	1.7
Sparse mangrove to HAL	1217	0.9
Sand to HAL	675	0.51
Vegetation to HAL	55159	42.00
Wetlands to HAL	3487	2.6

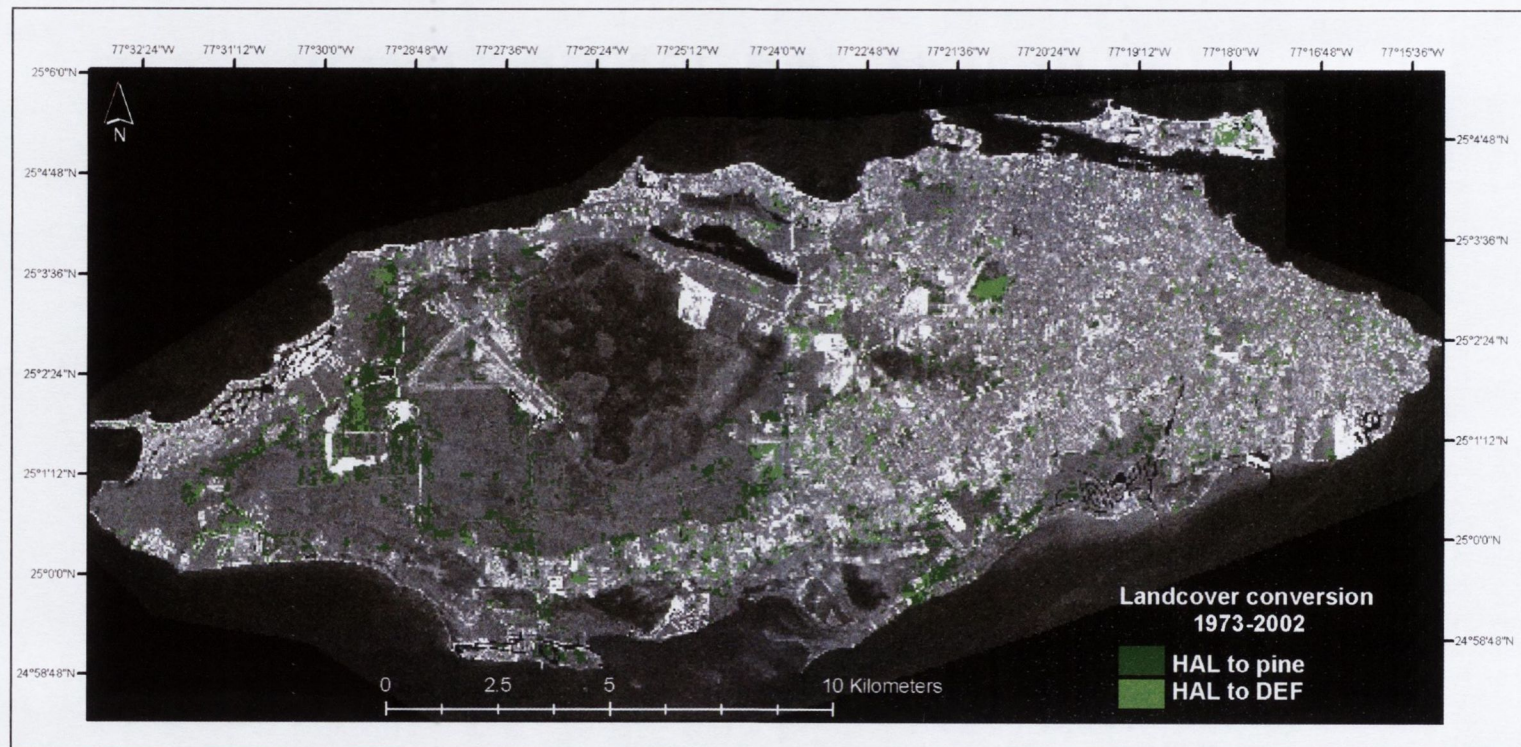


Figure 8.19. Conversion from HAL to pine and DEF land cover between 1973-2002.

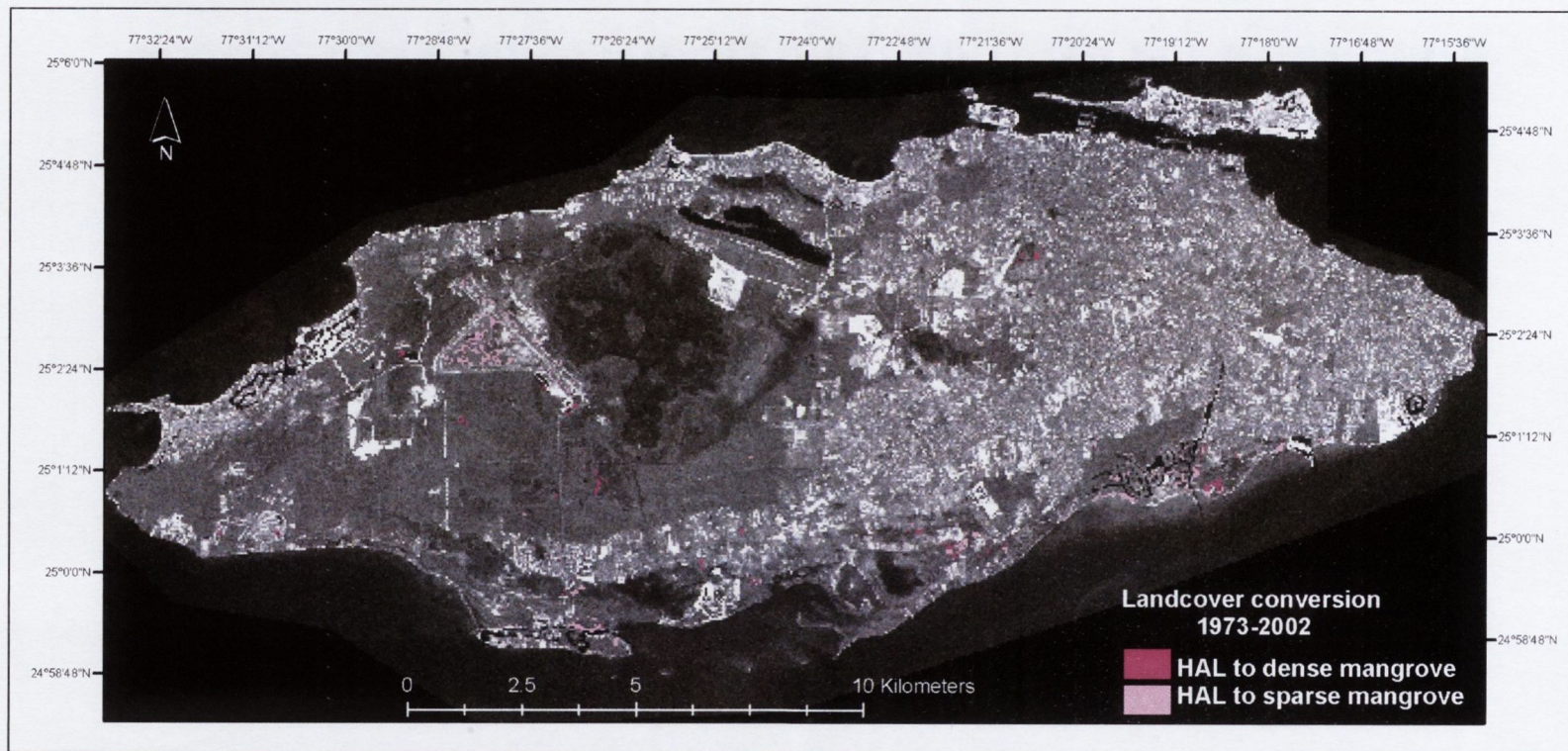


Figure 8.20. Conversion from HAL to wetlands (dense and sparse mangrove) land cover between 1973-2002.

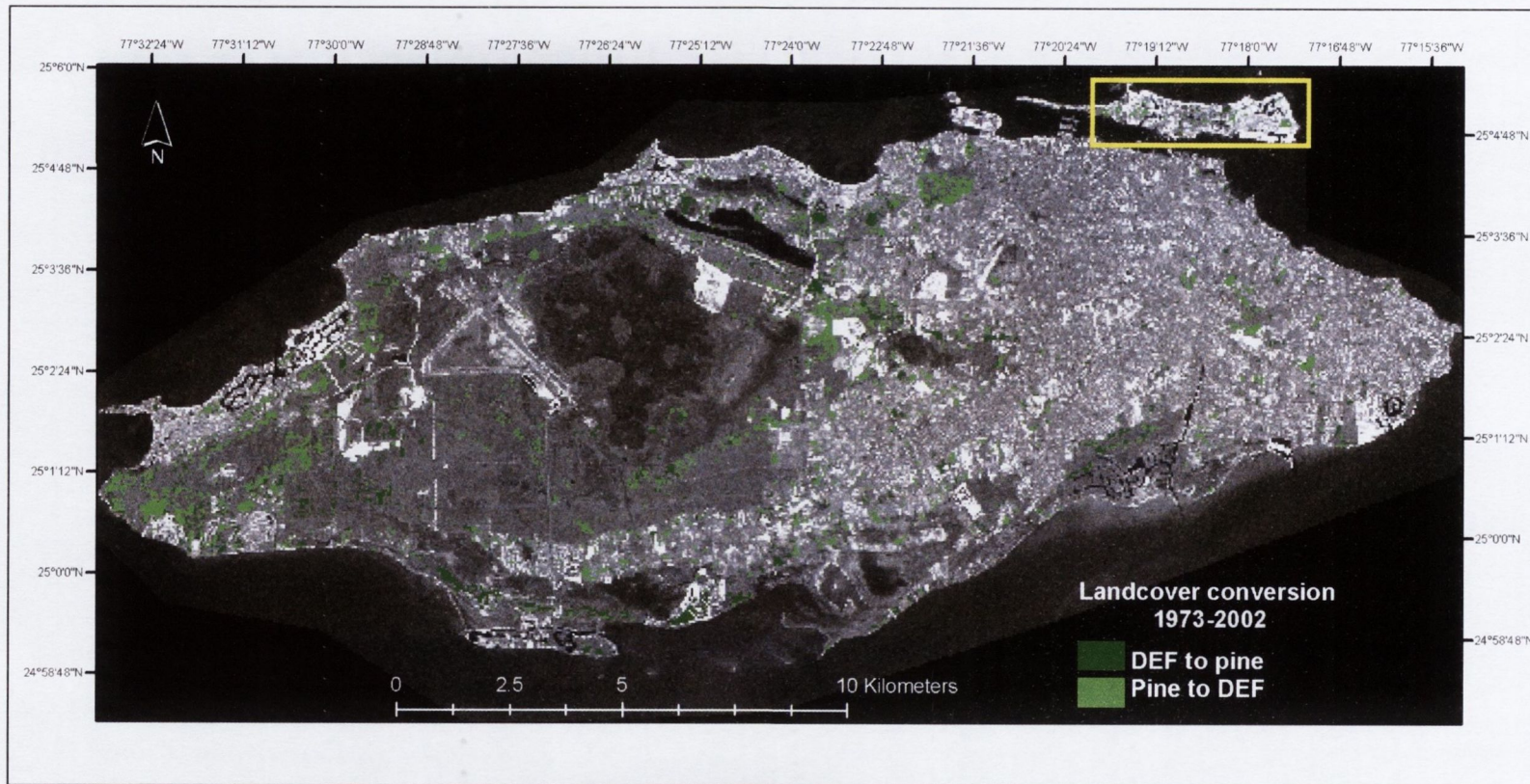


Figure 8.21. Conversion from pine to DEF and DEF to pine land cover between 1973-2002.

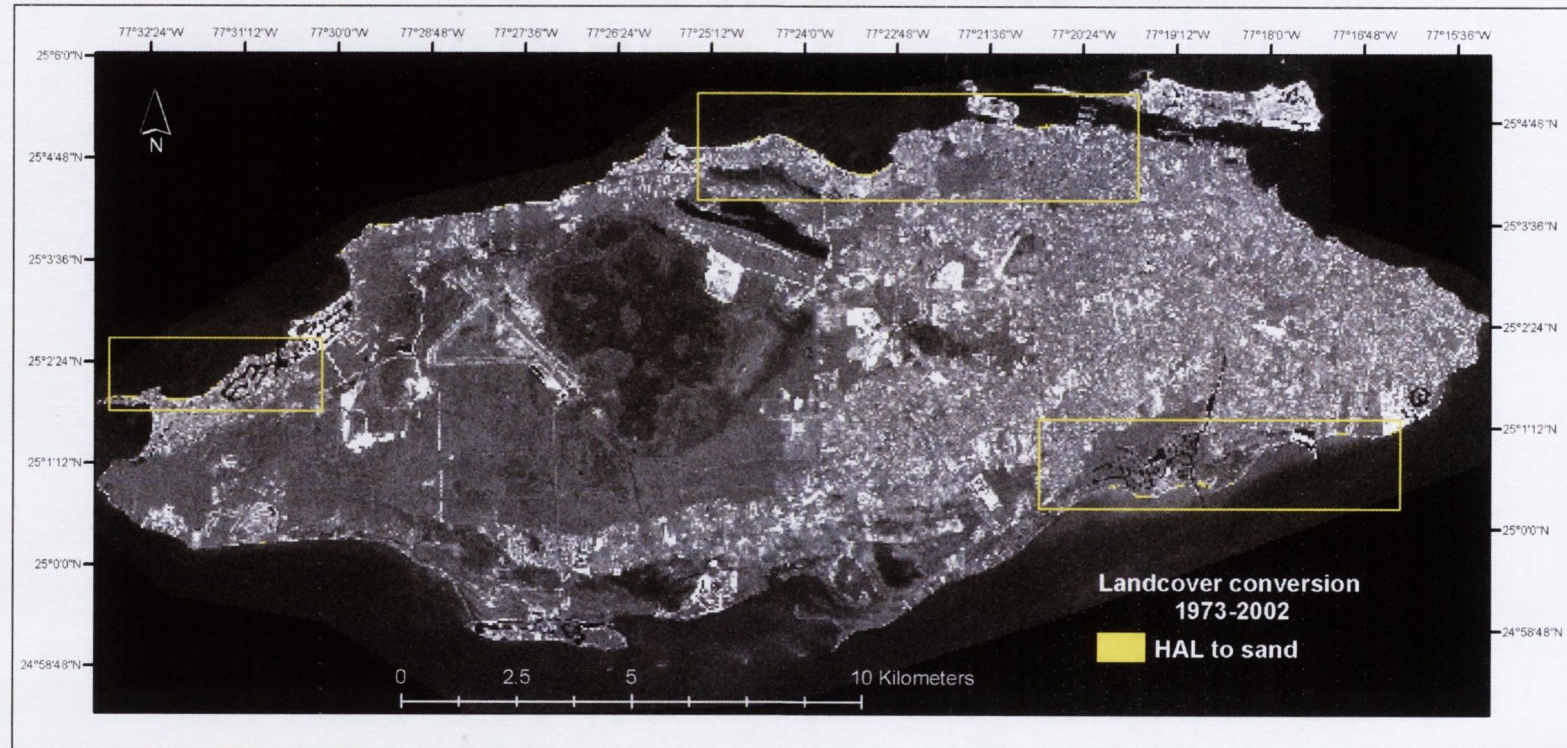


Figure 8.22. Conversion from HAL to sand between 1973 and 2002.

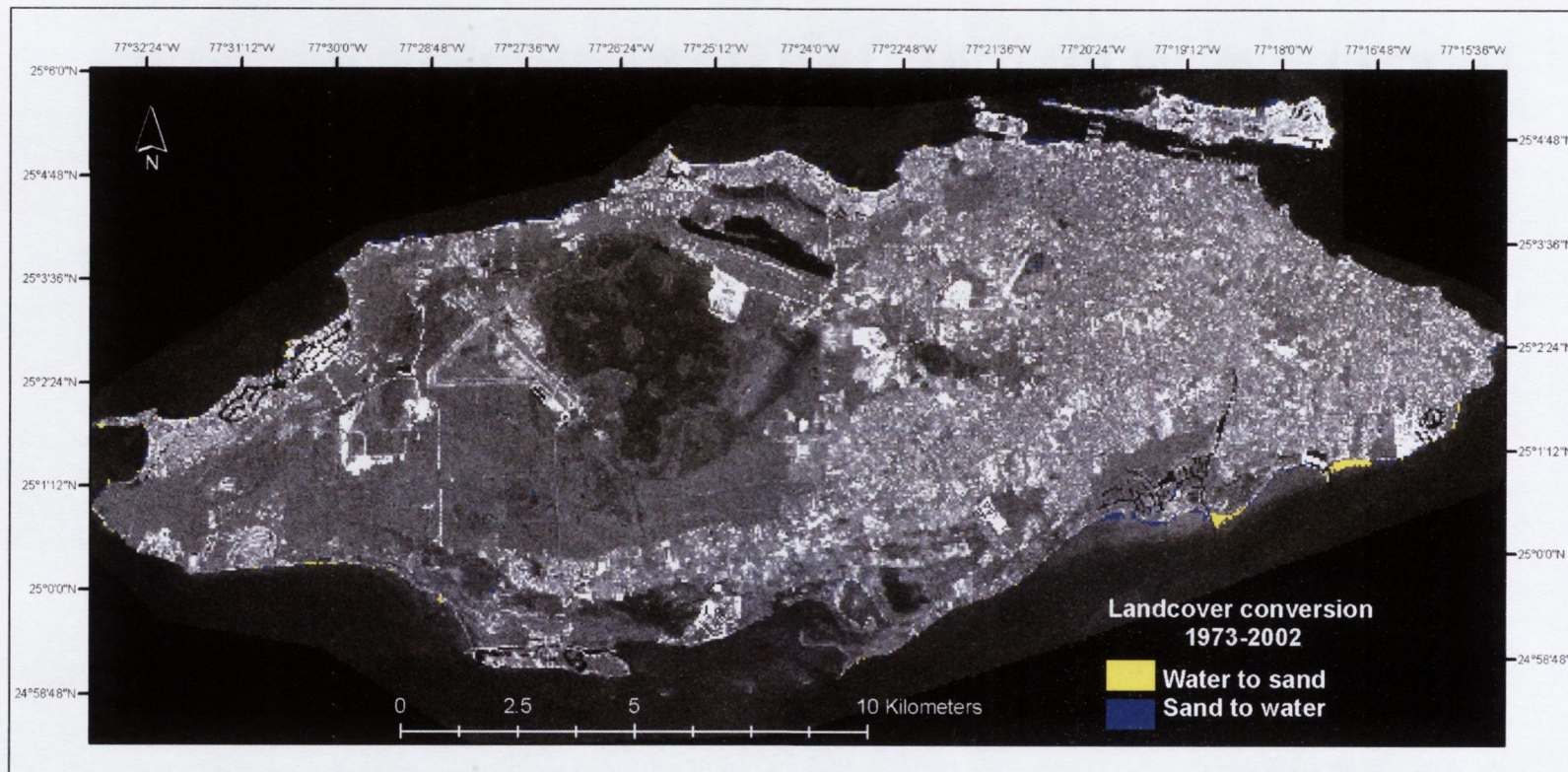


Figure 8.23. Conversion from sand to water and water to sand between 1973 and 2002.

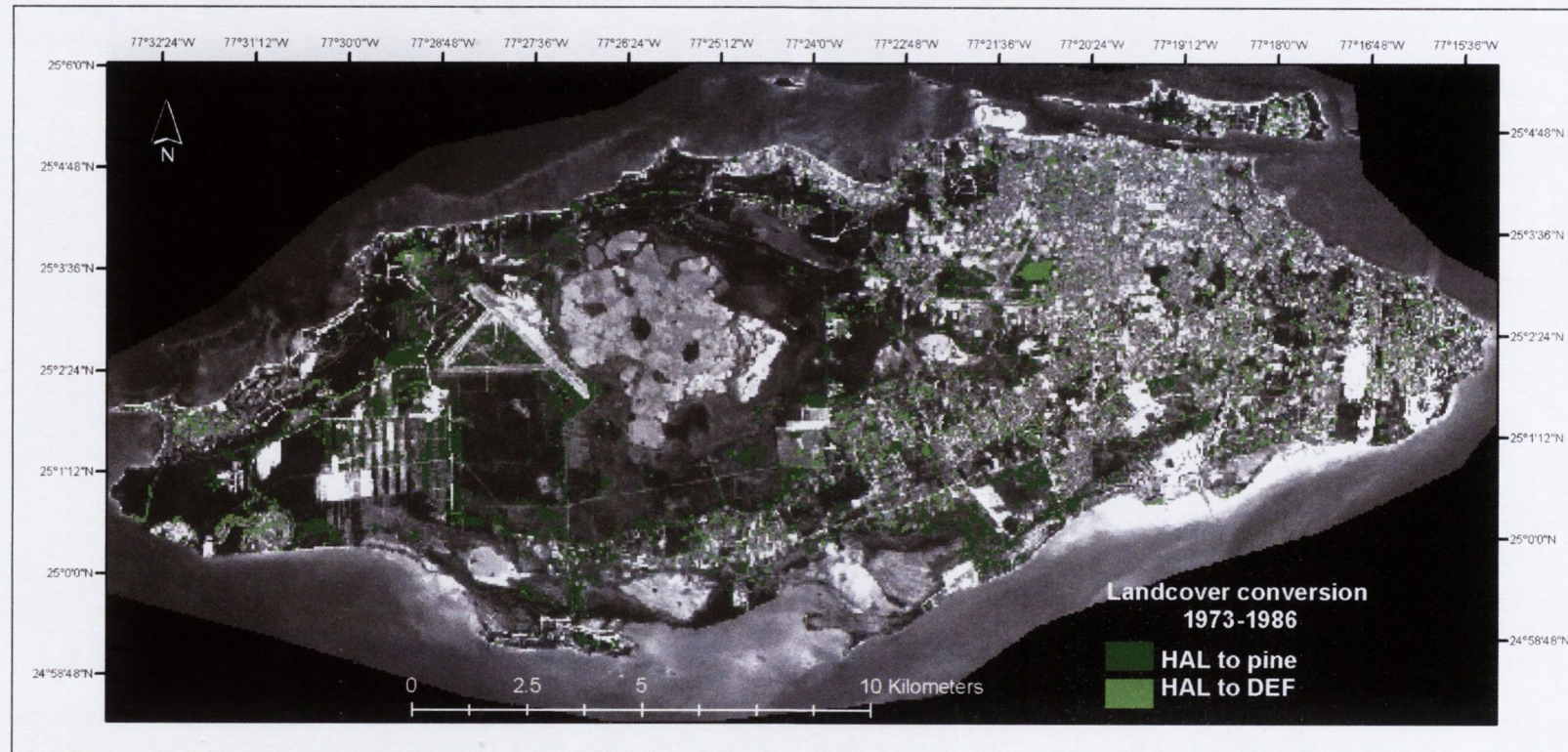


Figure 8.24. Conversion from HAL to pine and DEF between 1973 and 1986.

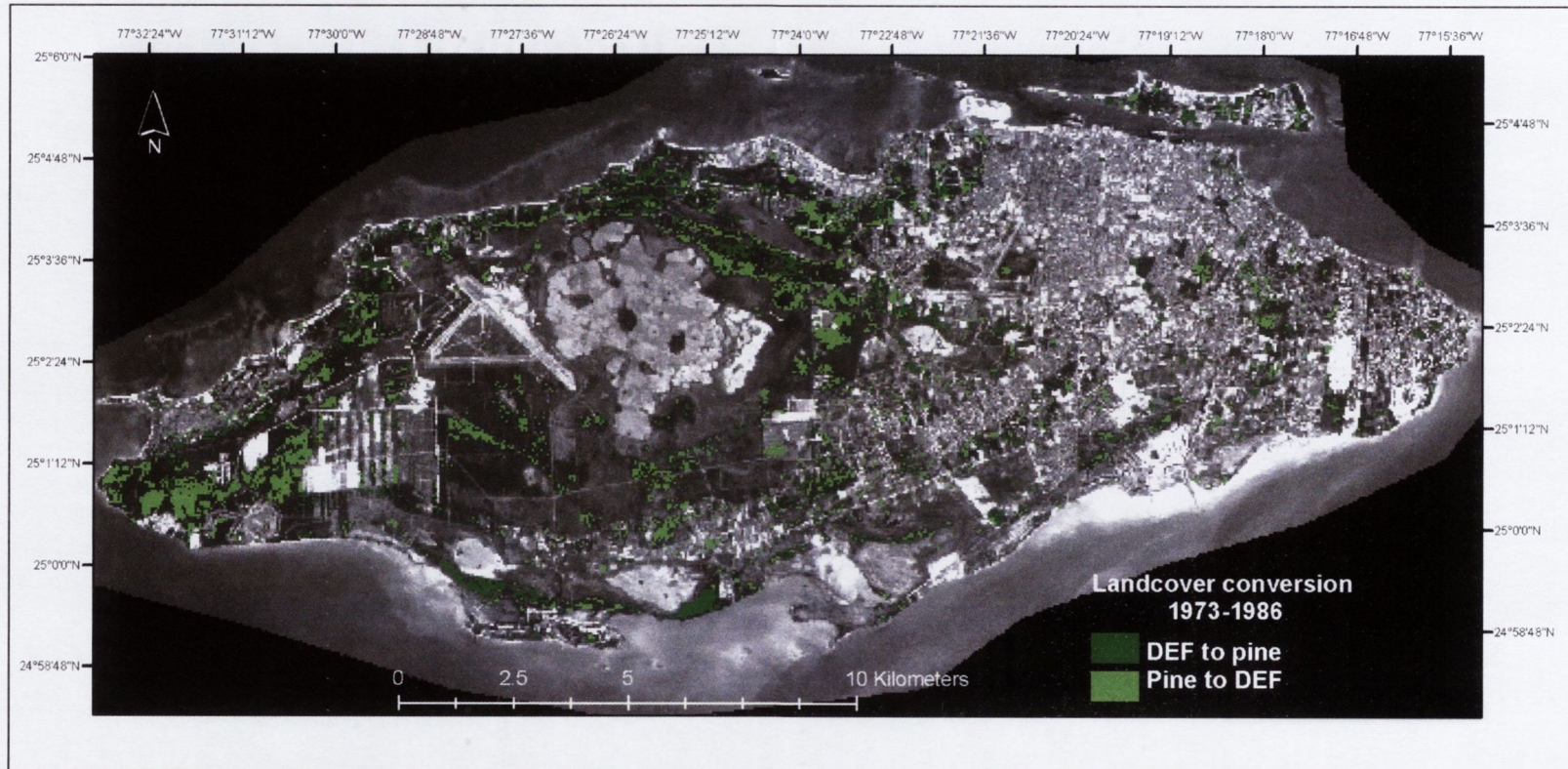


Figure 8.25. Conversion from pine to DEF and DEF to pine between 1973 and 1986.

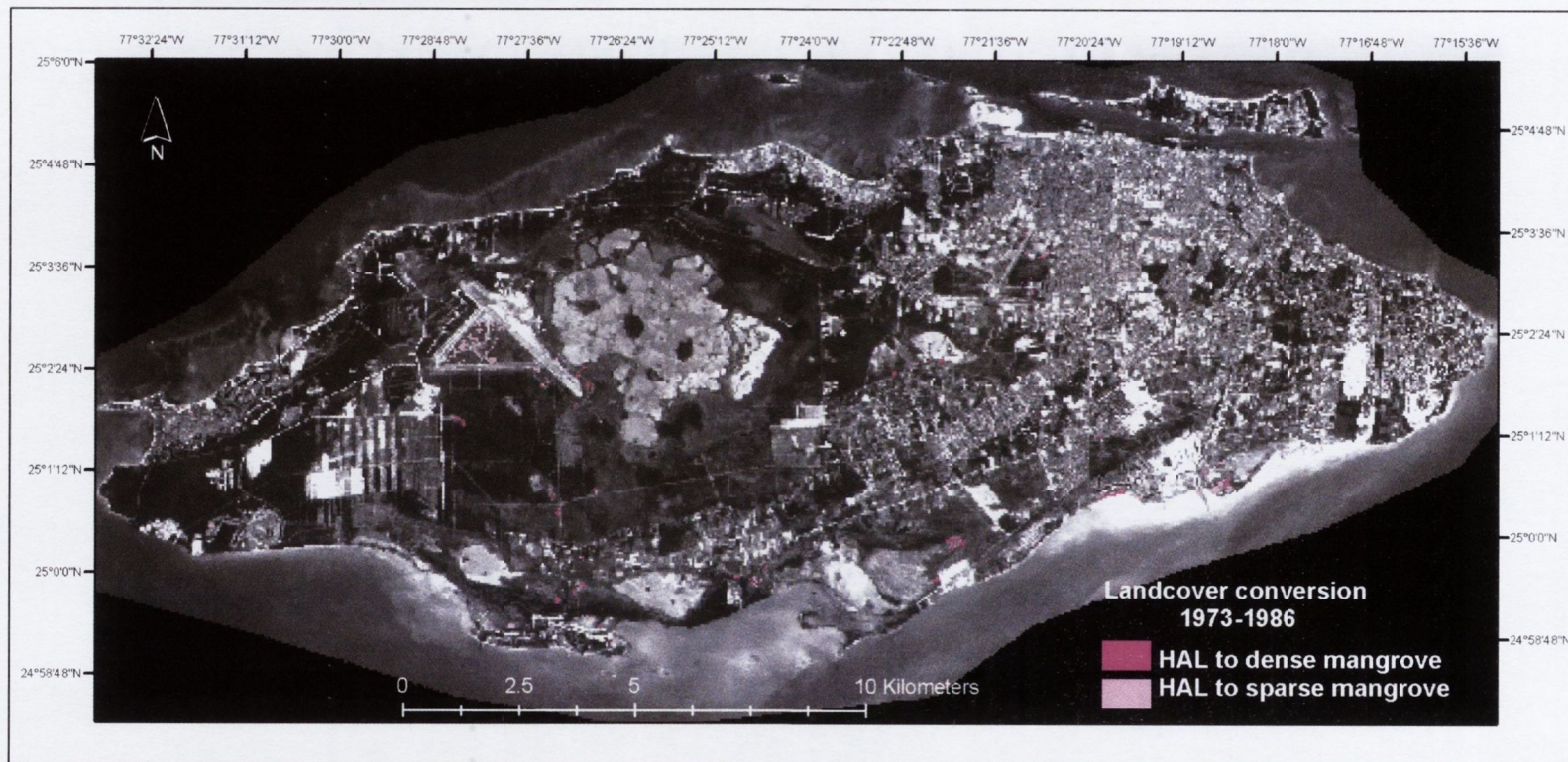


Figure 8.26. Conversion from HAL to dense and sparse mangrove between 1973 and 1986.

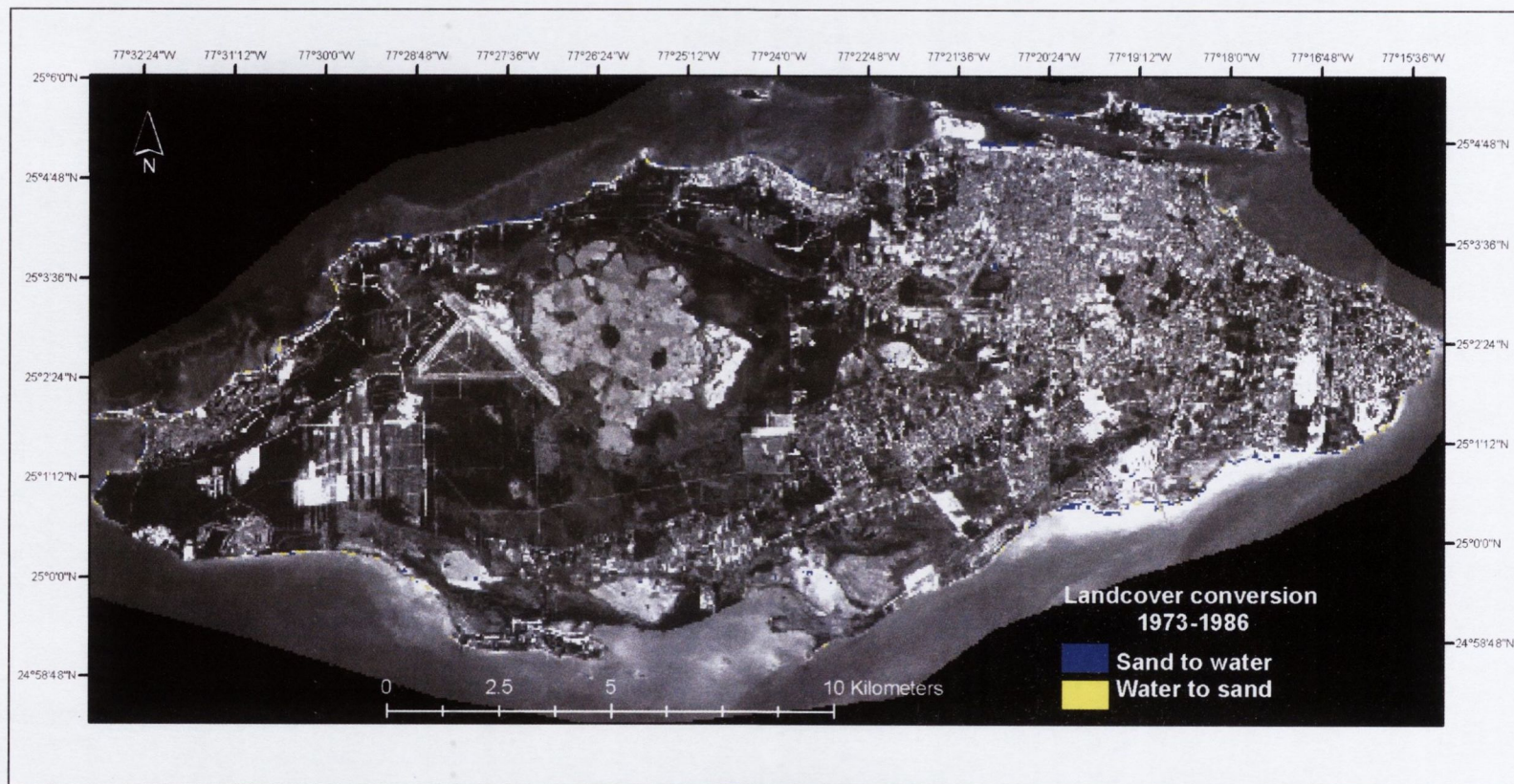


Figure 8.27. Conversion from water to sand and sand to water between 1973 and 1986.

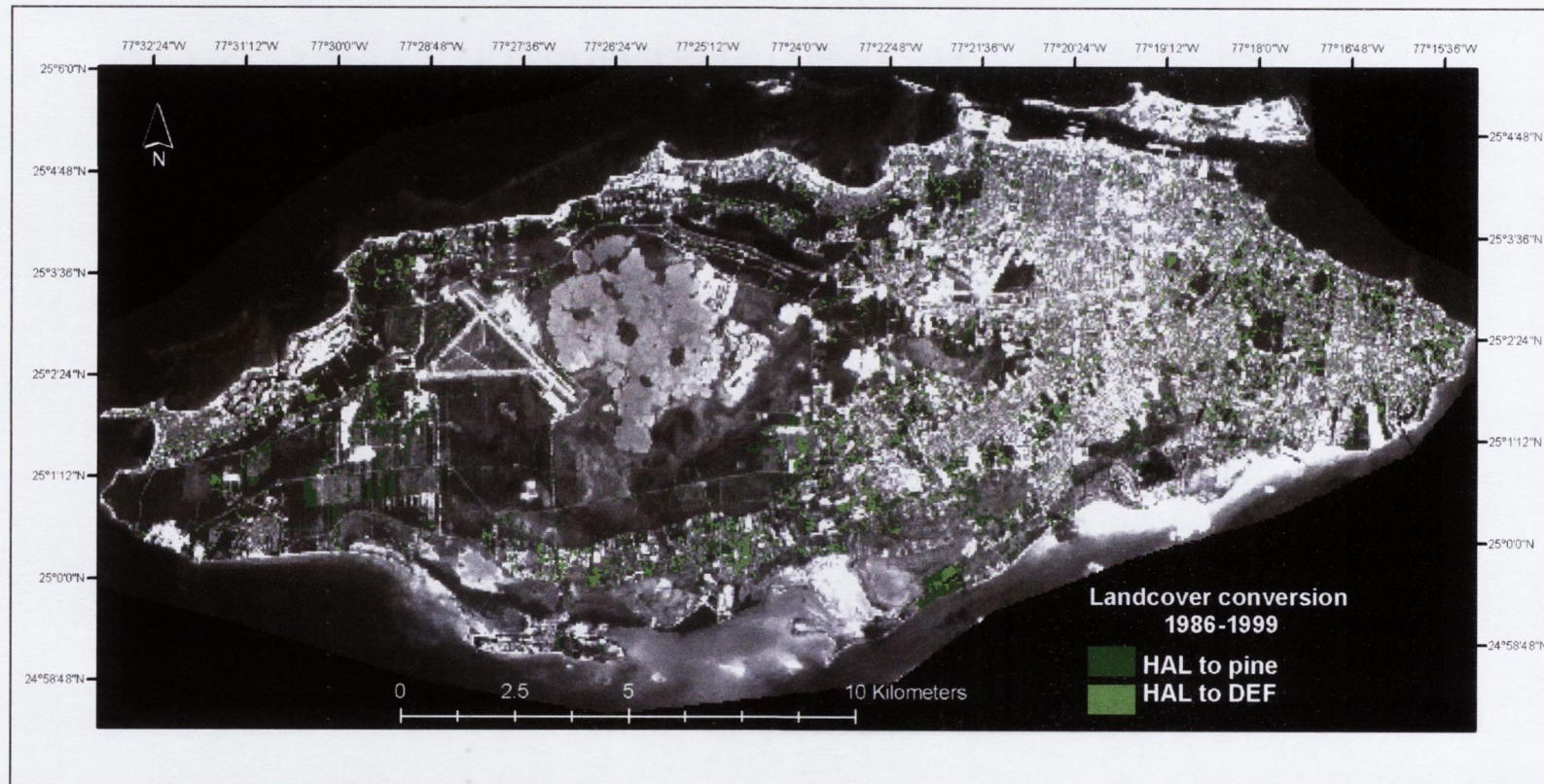


Figure 8.28. Conversion from HAL to pine and DEF between 1986 and 1999.

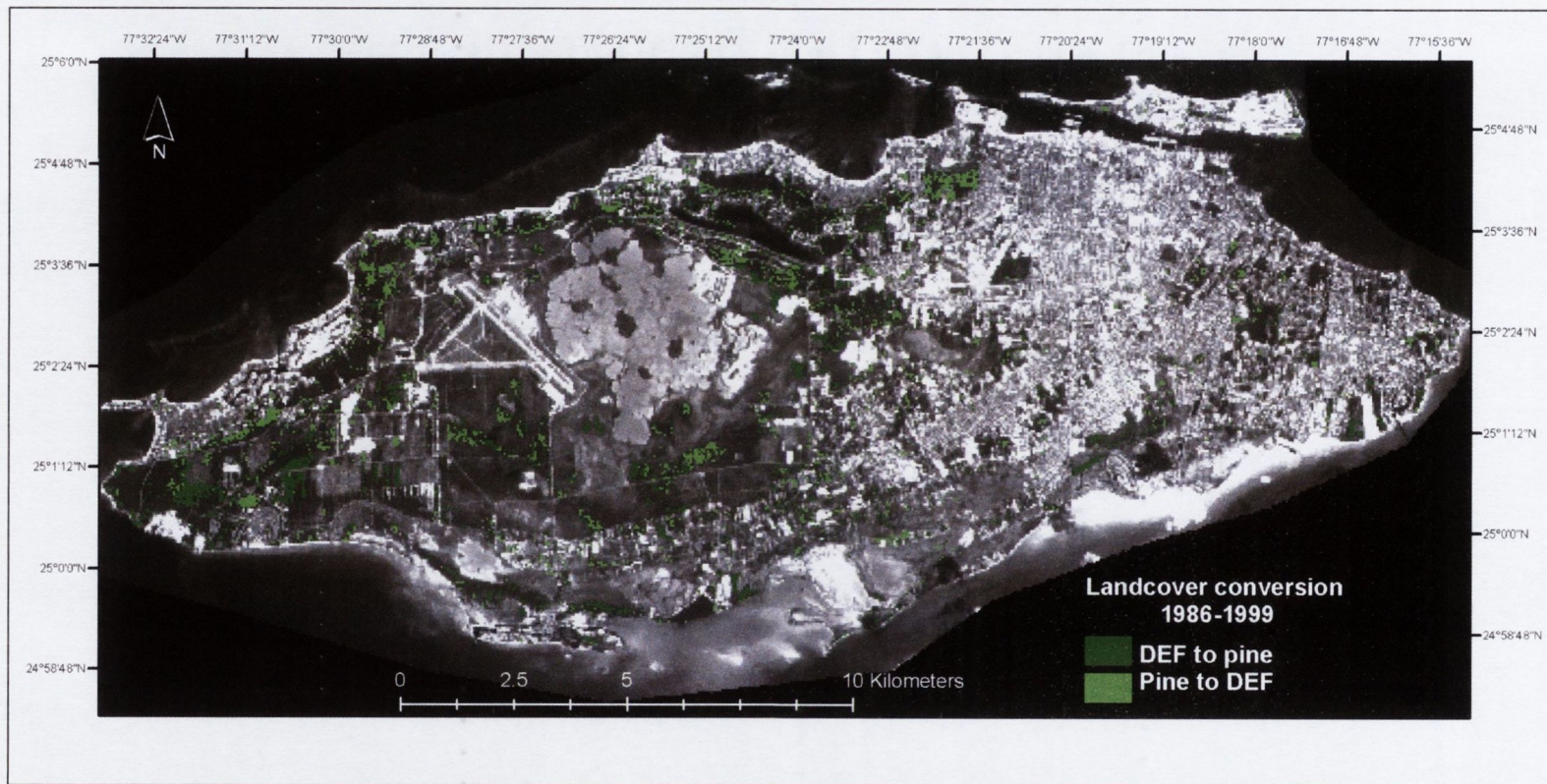


Figure 8.29. Conversion from pine to DEF and DEF to pine between 1986 and 1999.

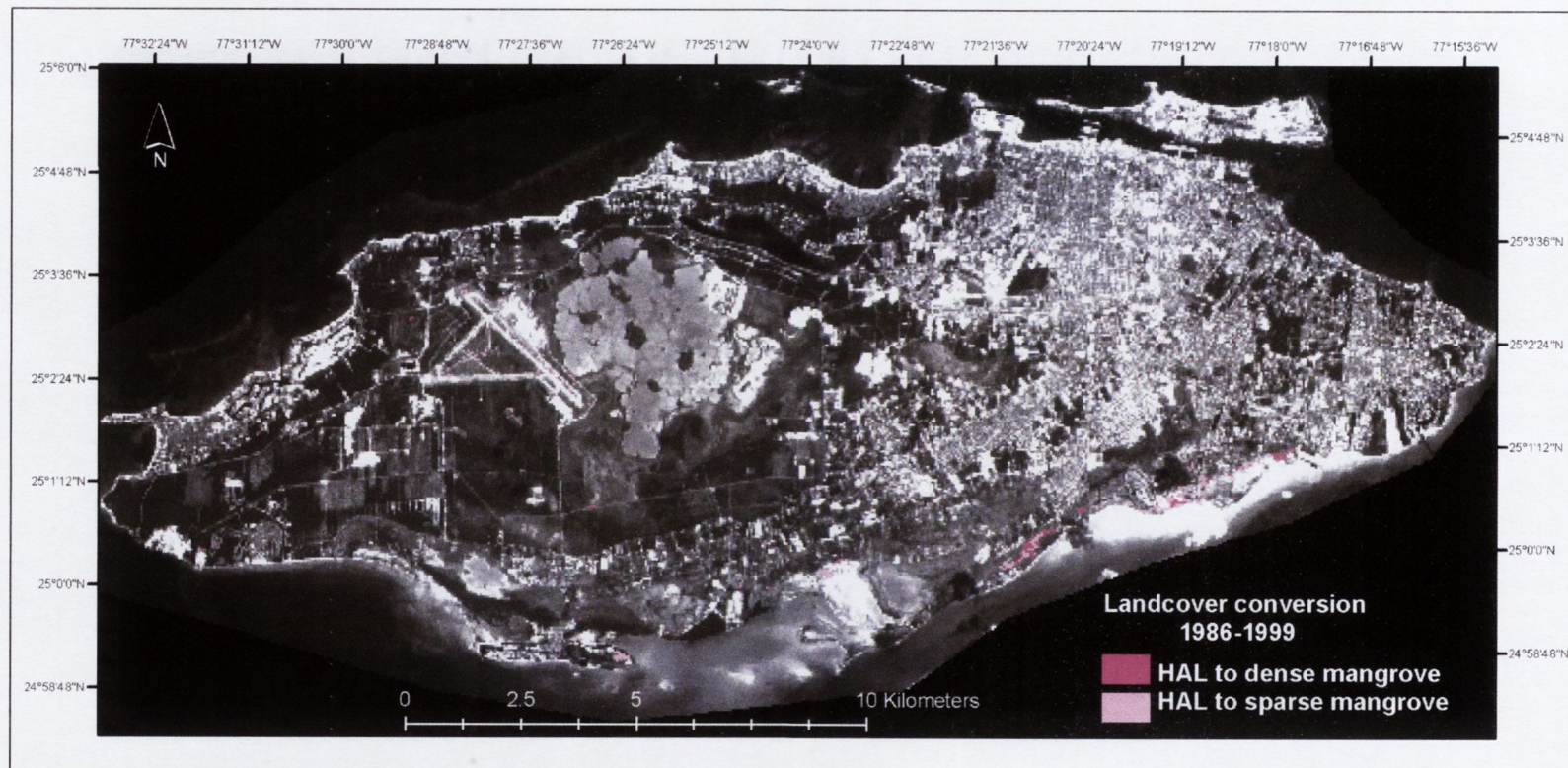


Figure 8.30. Conversion from HAL to dense and sparse mangrove between 1986 and 1999.

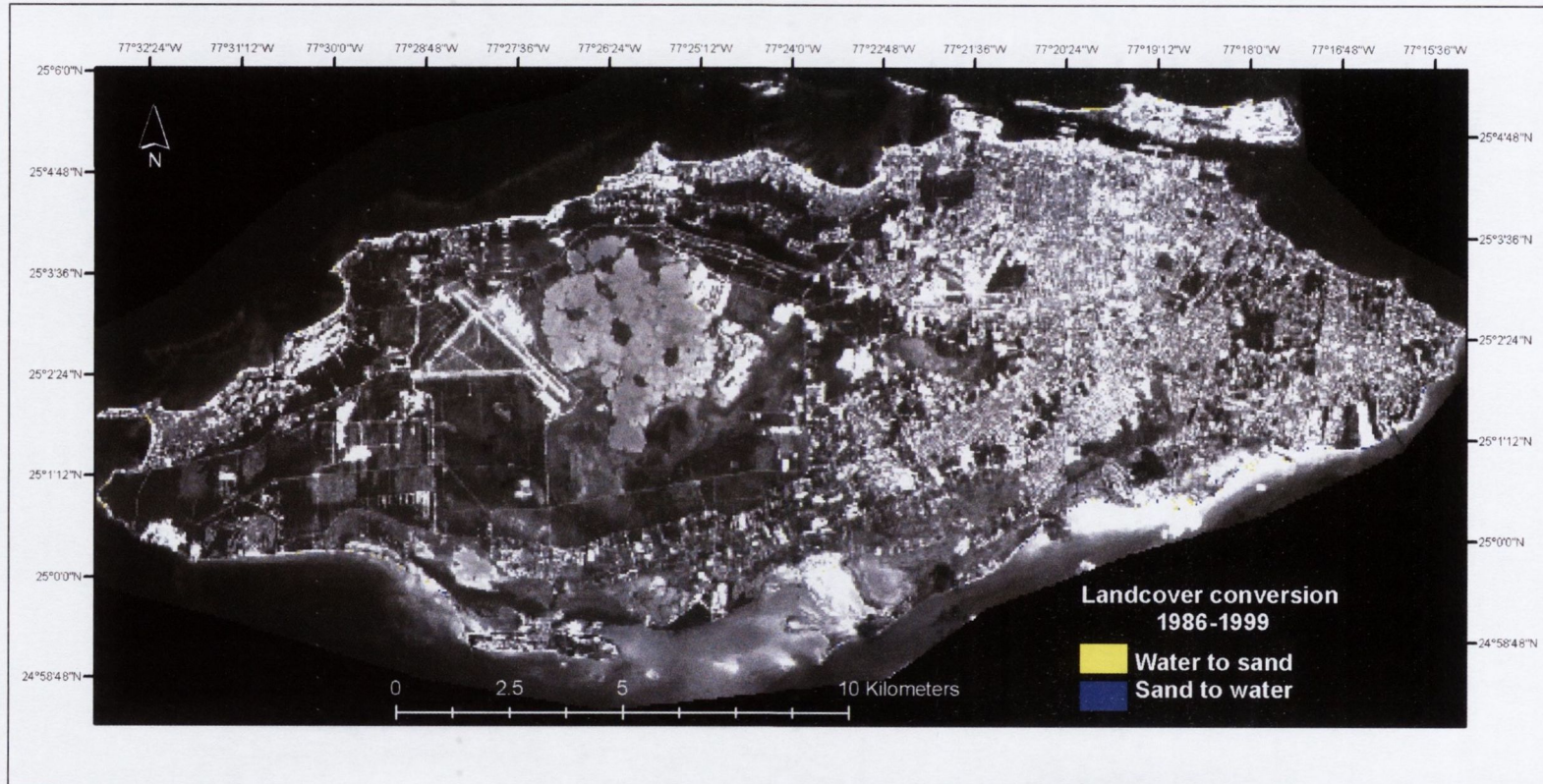


Figure 8.31. Conversion from sand to water and water to sand between 1986 and 1999.

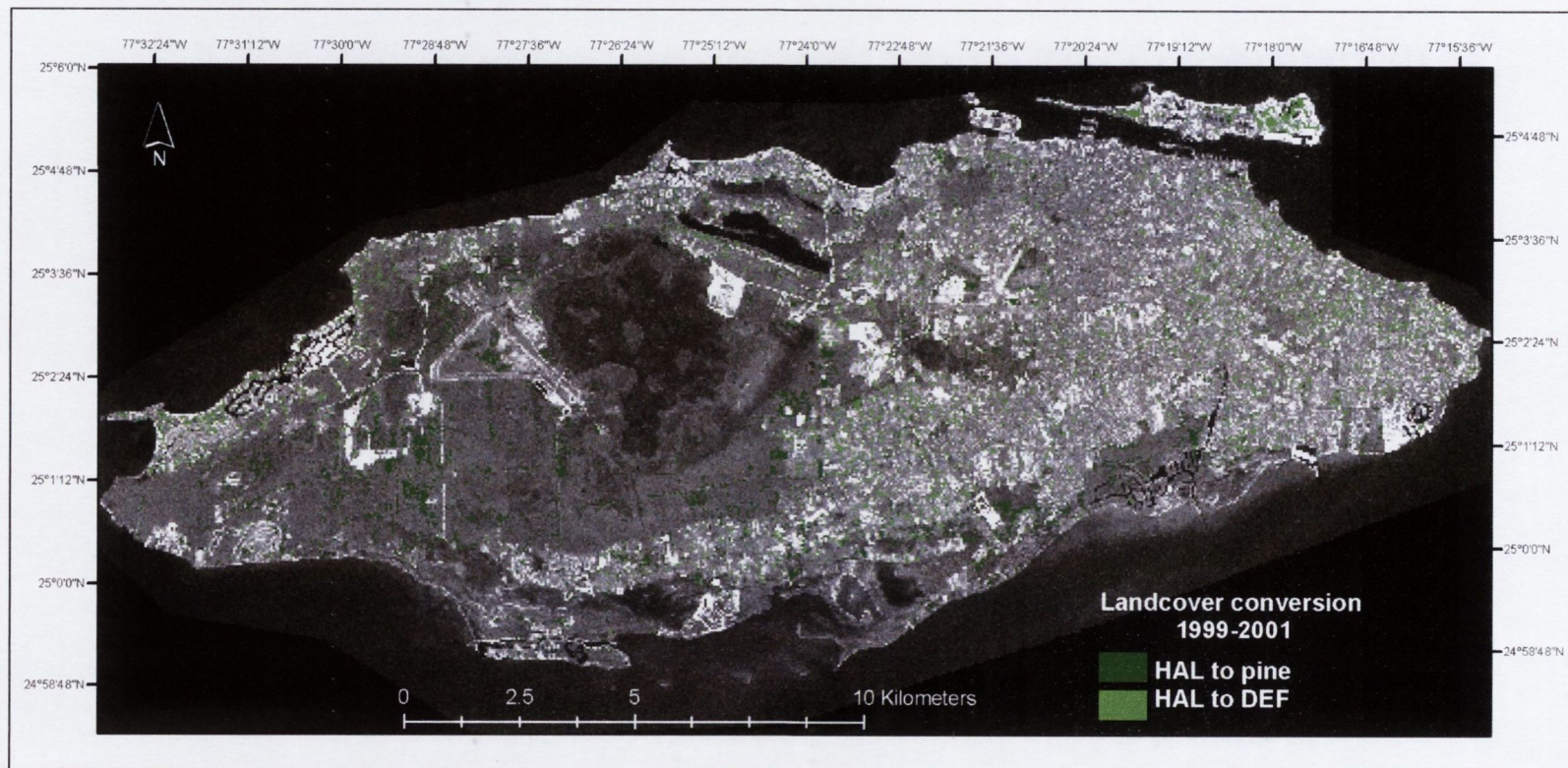


Figure 8.32. Conversion from HAL to pine and DEF between 1999 and 2001.

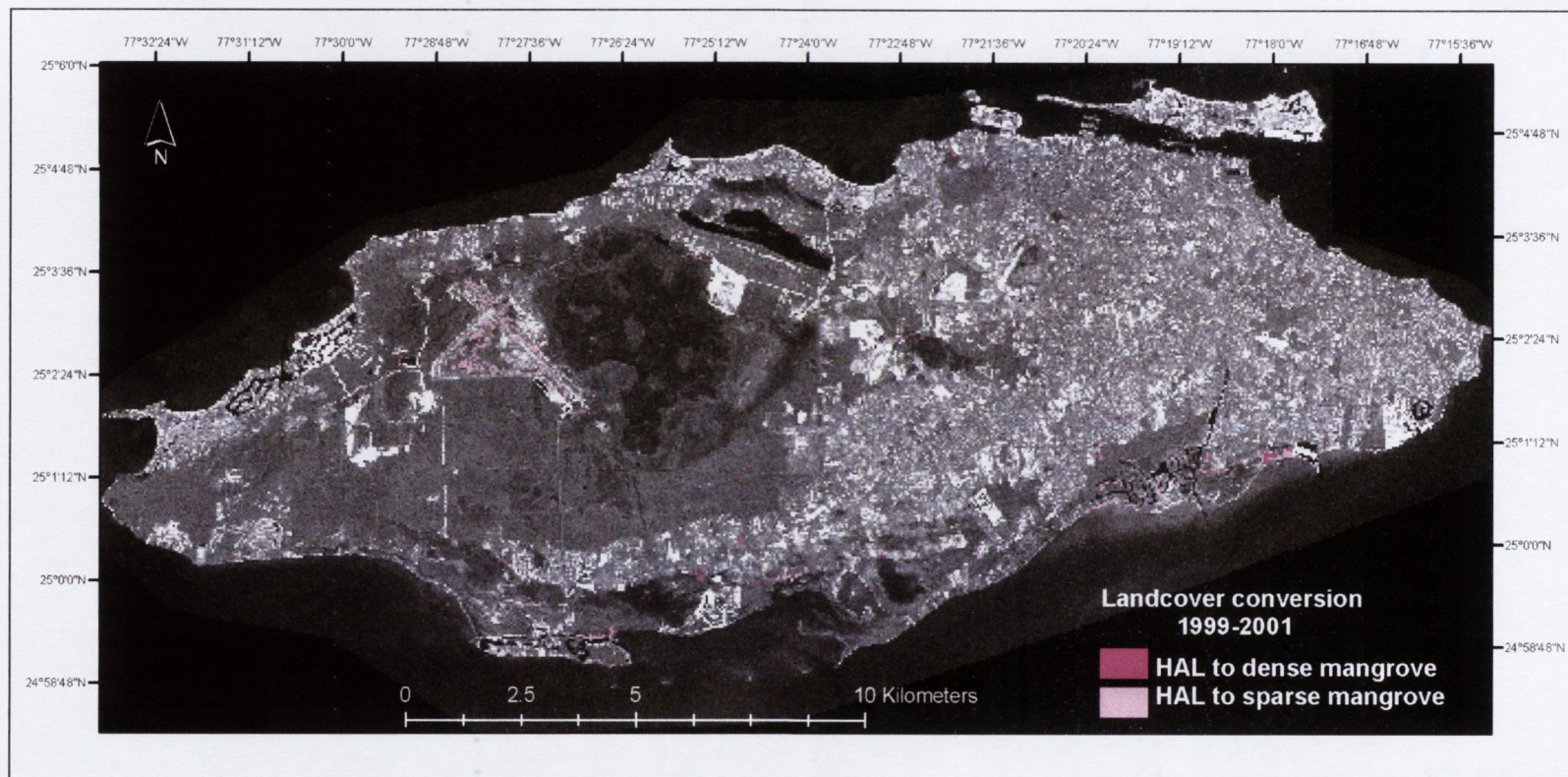


Figure 8.33. Conversion from HAL to dense and sparse mangrove between 1999 and 2001.

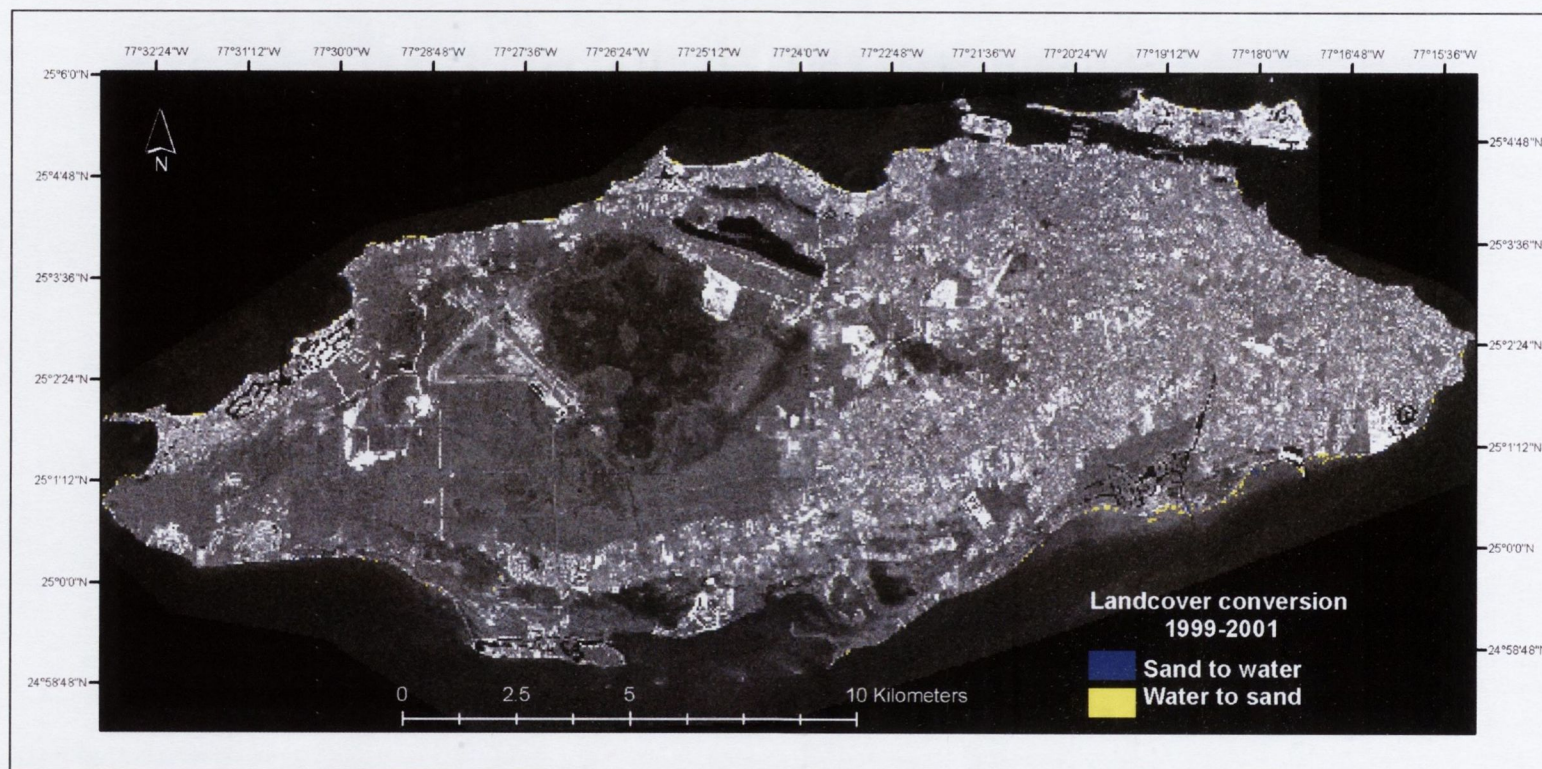


Figure 8.34. Conversion from water to sand and sand to water between 1999 and 2001.

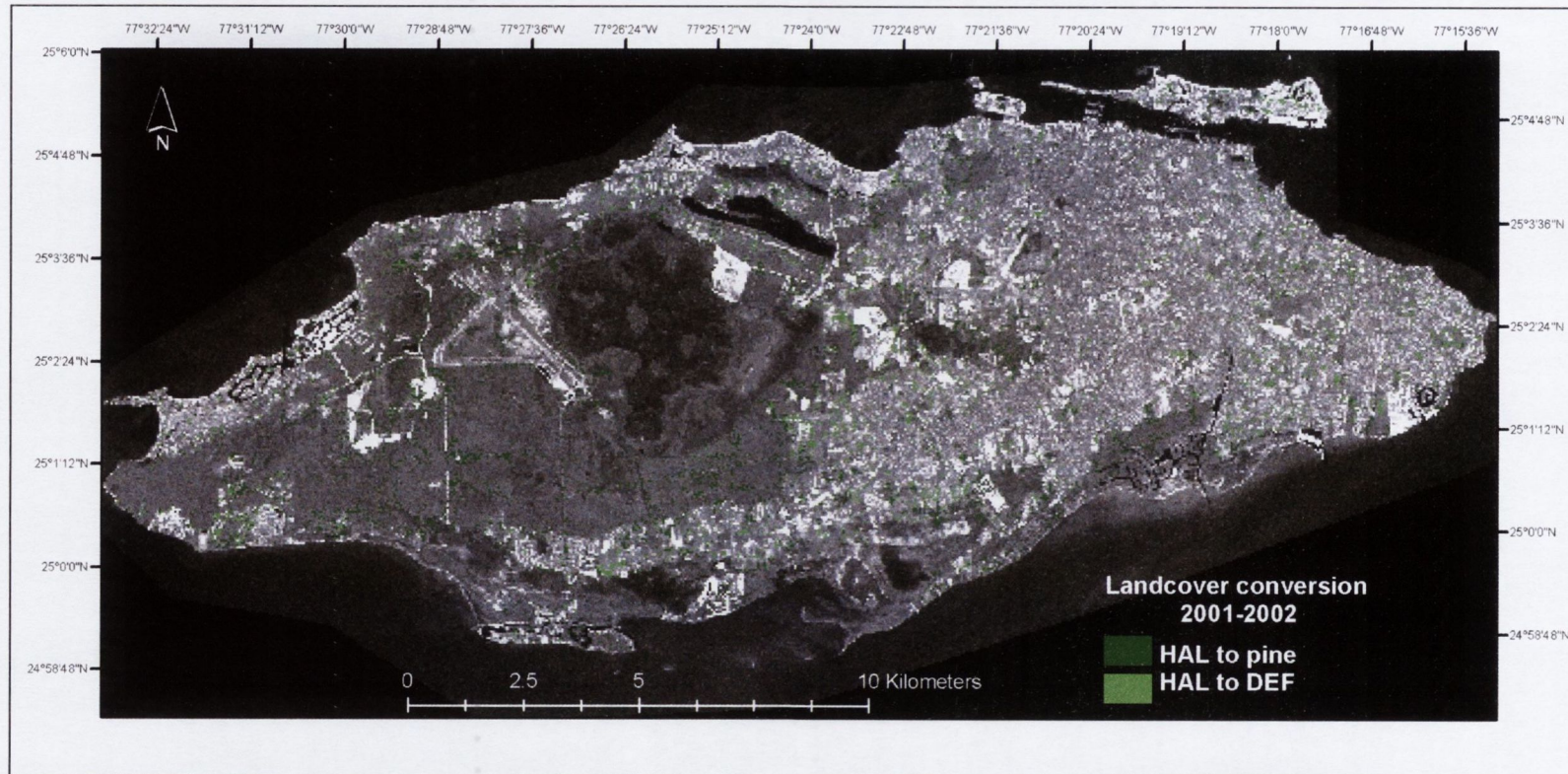


Figure 8.35. Conversion from HAL to pine and DEF between 2001 and 2002.

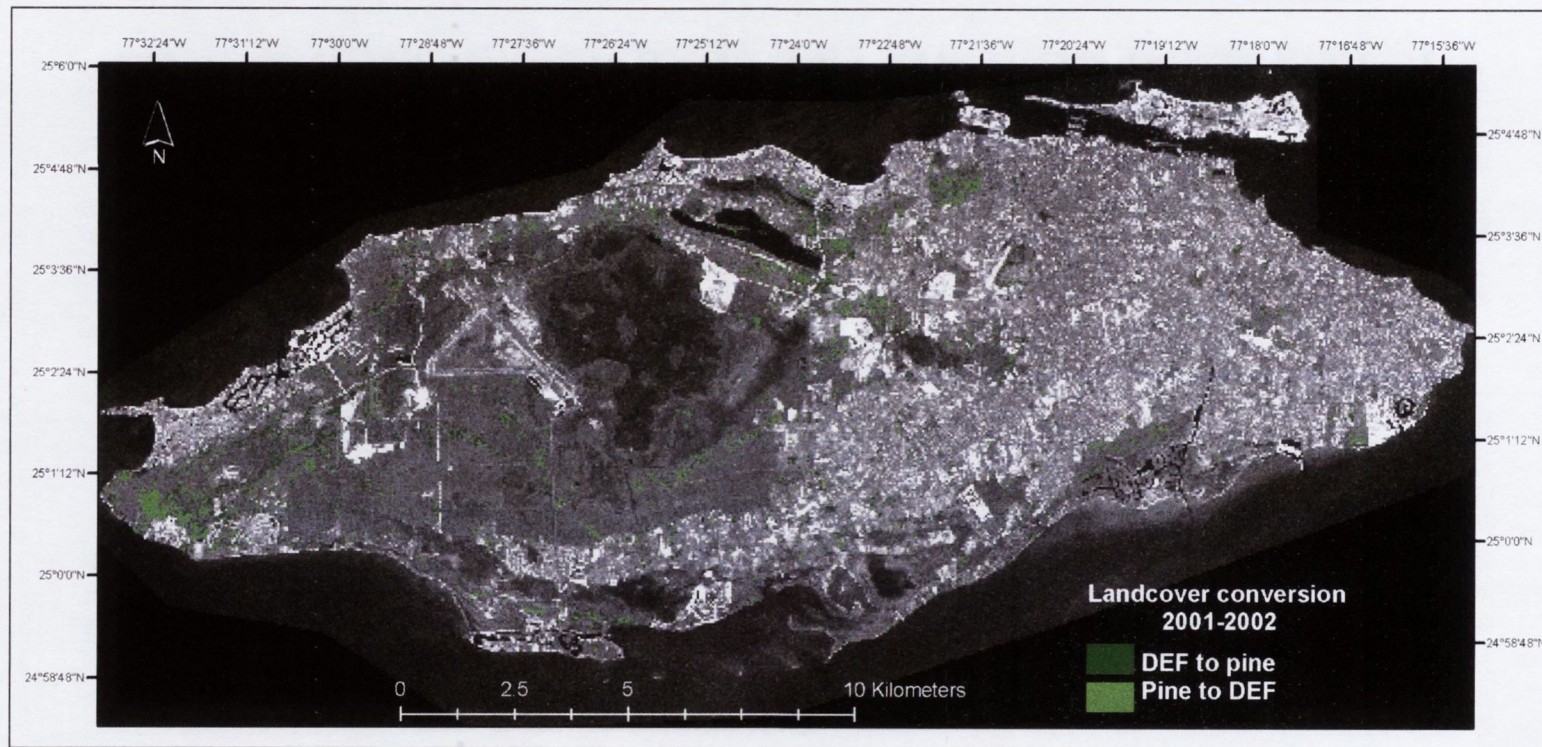


Figure 8.36. Conversion from pine to DEF and DEF to pine between 2001 and 2002.

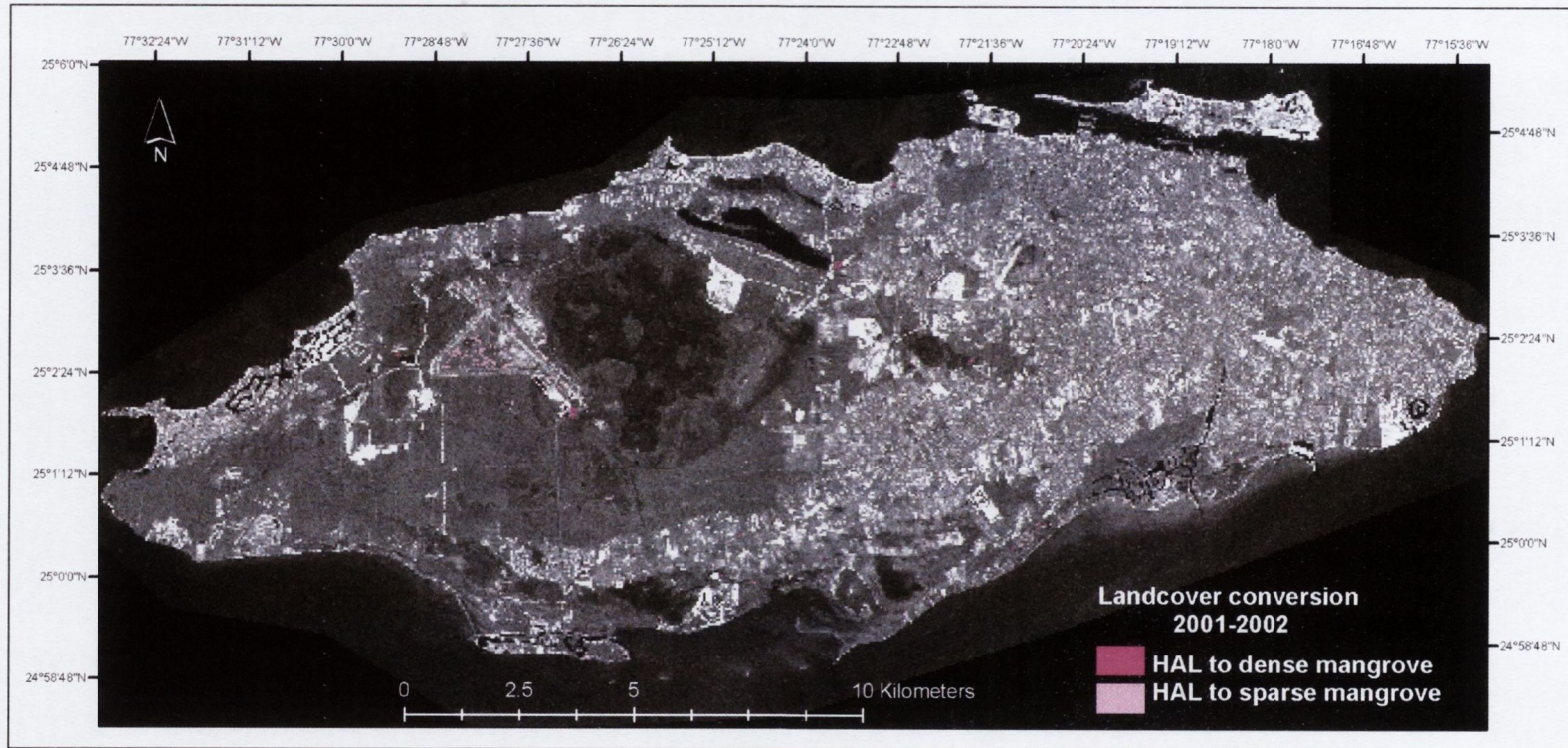


Figure 8.37. Conversion from HAL to dense and sparse mangroves between 2001 and 2002.

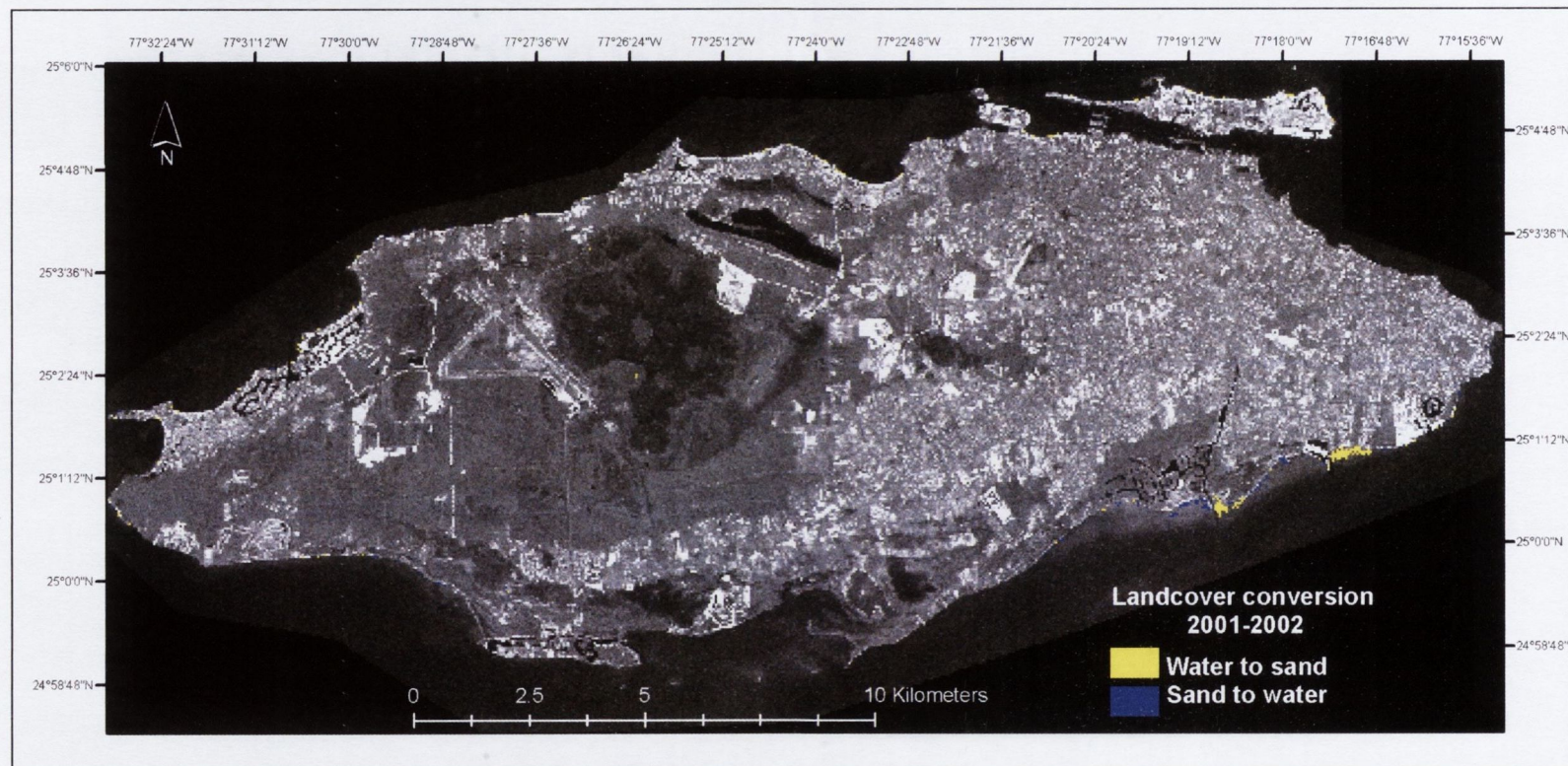


Figure 8.38. Conversion from water to sand and sand to water between 2001 and 2002.

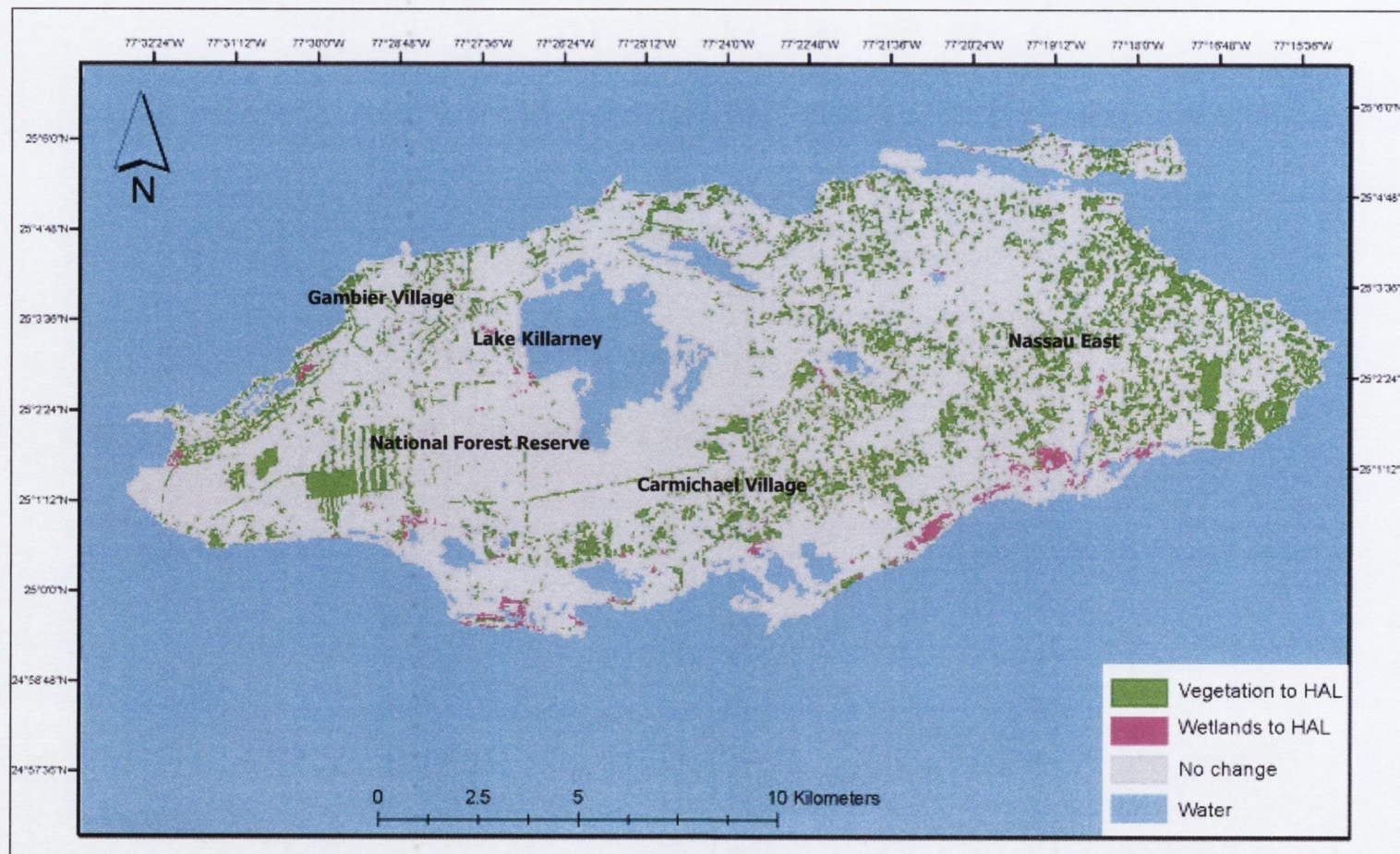


Figure 8.39. Human disturbance 1973-1986: Conversion of vegetation (DEF and pine) and wetlands (dense and sparse mangroves) to HAL.

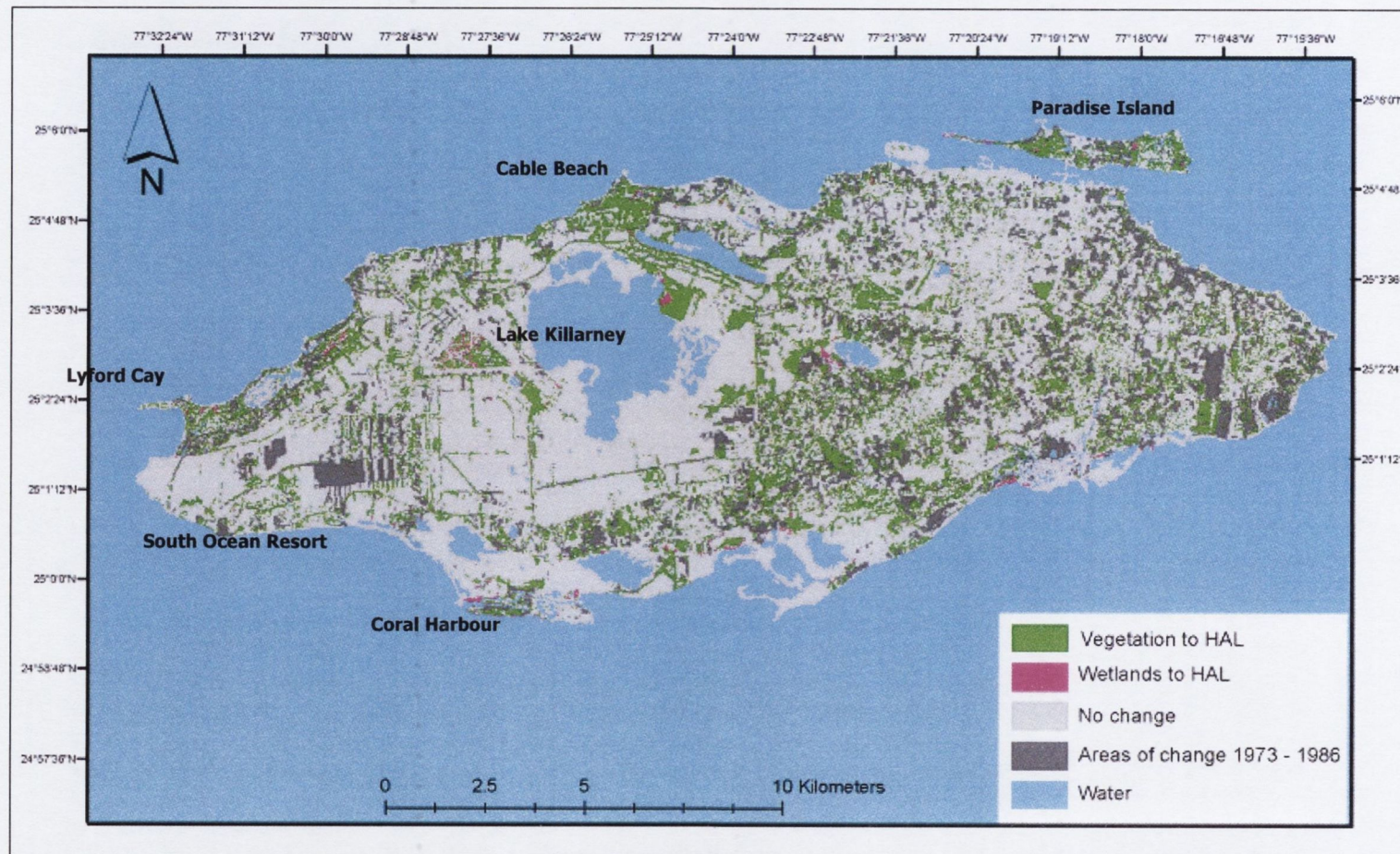


Figure 8.40. Human disturbance 1986-1999: Conversion of vegetation (DEF and pine) and wetlands (dense and sparse mangroves) to HAL.

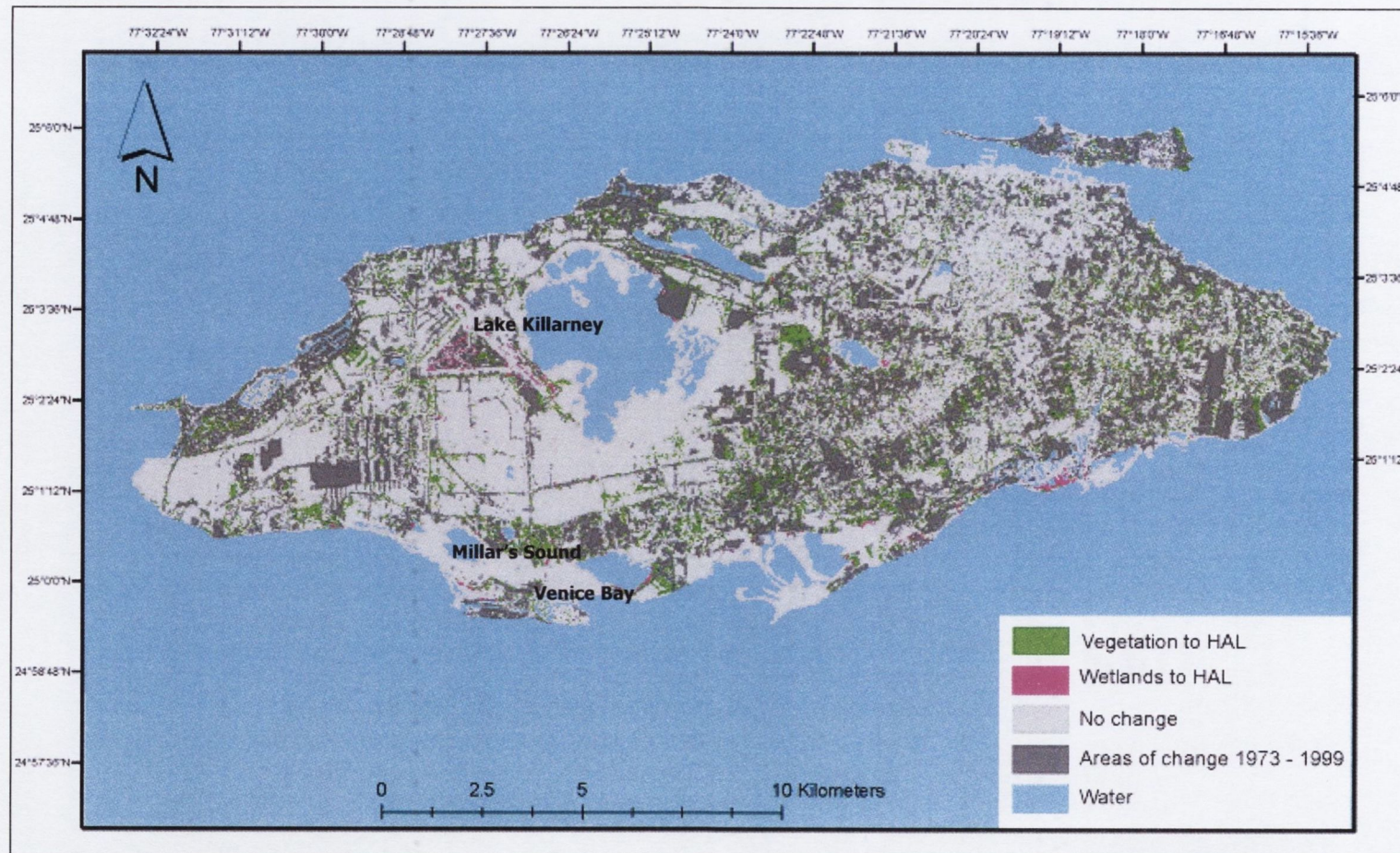


Figure 8.41. Human disturbance 1999-2001: Conversion of vegetation (def and pine) and wetlands (dense and sparse mangroves) to HAL between 1999 and 2001.

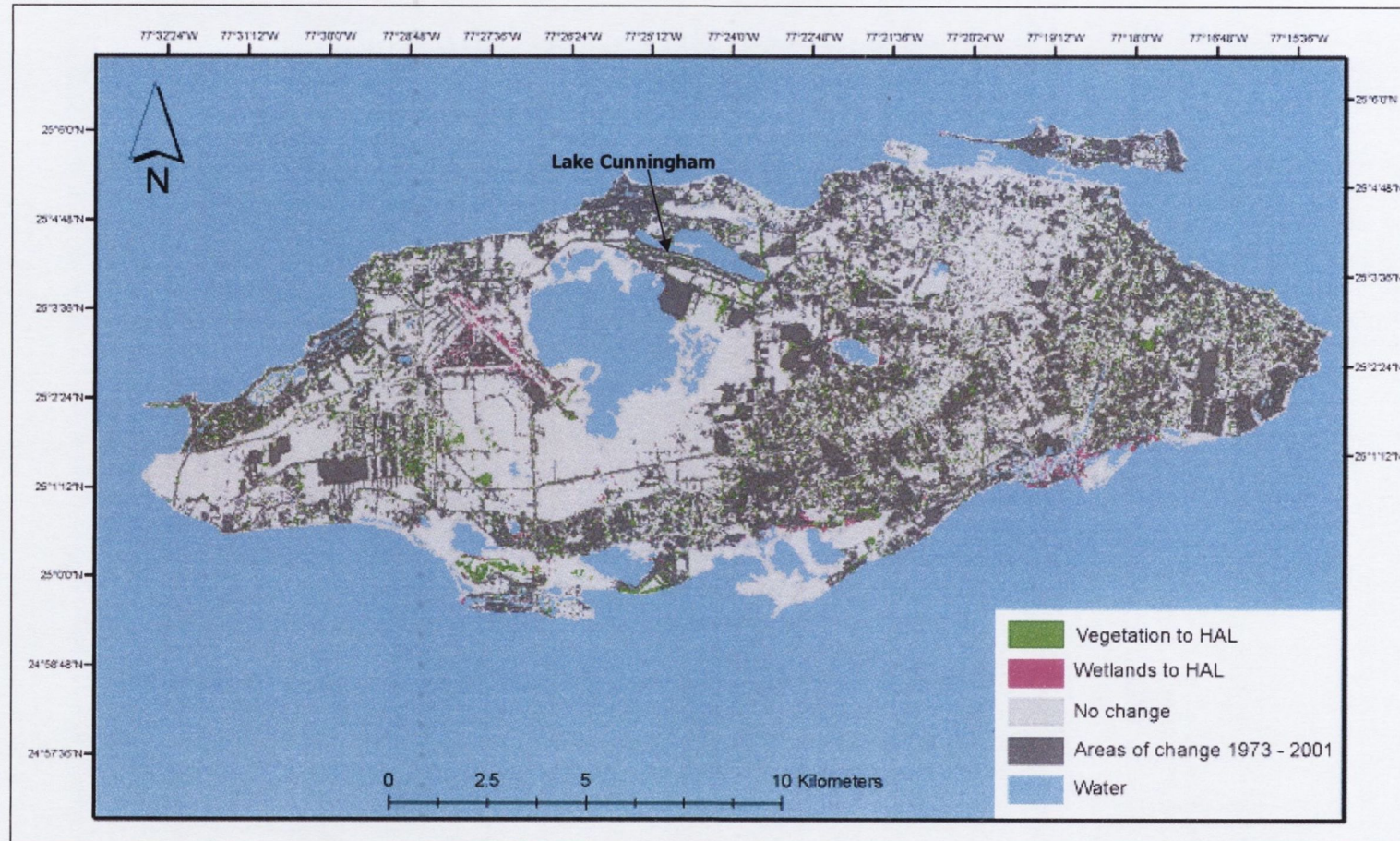


Figure 8.42. Human disturbance 2001-2002: Conversion of vegetation (def and pine) and wetlands (dense and sparse mangroves) to HAL.

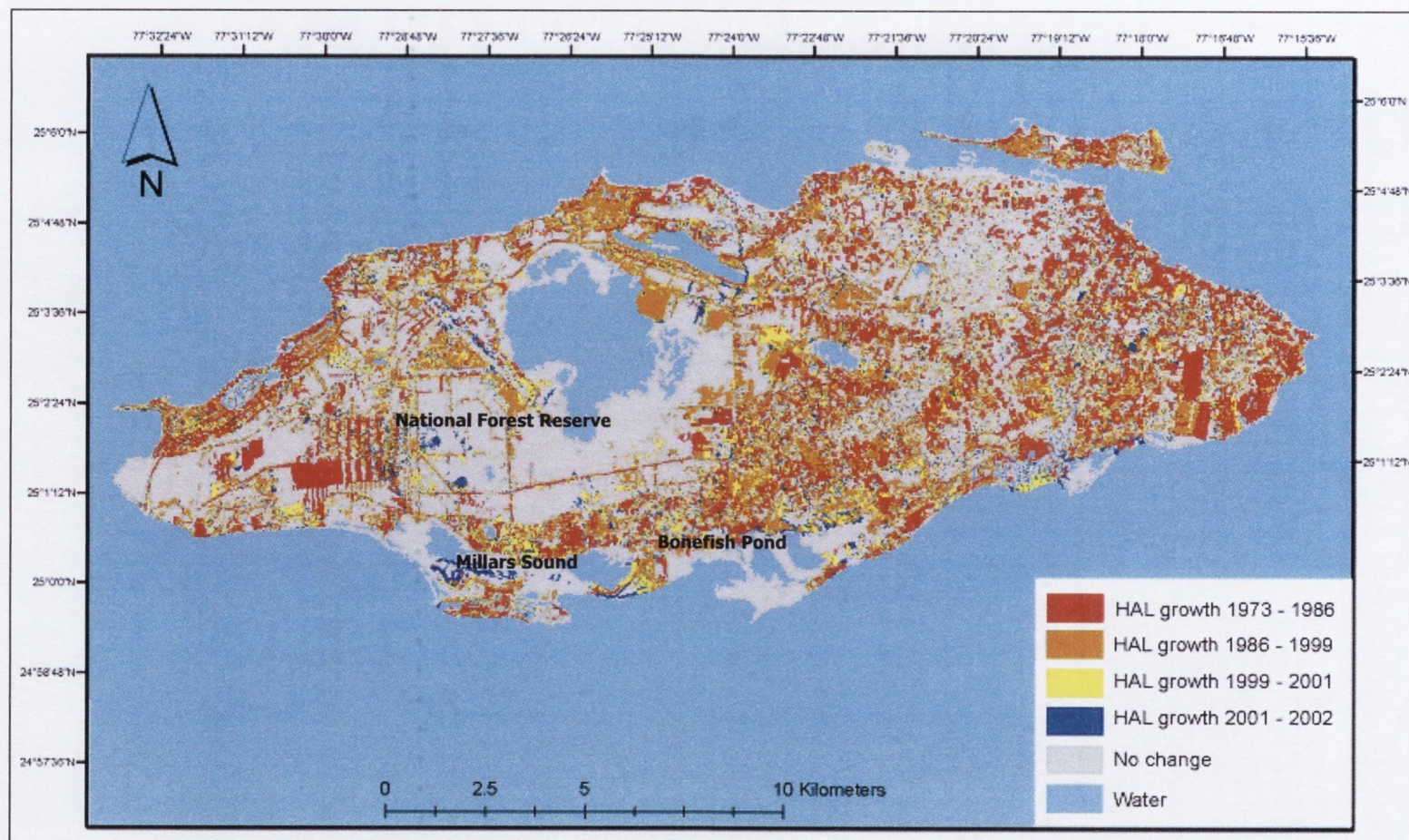


Figure 8.43. Human disturbance 1973-2002: Conversion of pine, def, sparse mangrove and dense mangrove land cover to HAL.

Table 8.24. Summary statistics estimated from the land cover classification describing overall changes in HAL between 1973 and 2002.

Time interval	Increase in area (hectares)	Proportional increase in total area (%)
1973-1986	850	+5.03
1986-1999	1810	+8.9
1999-2001	80	+0.1
2001-2002	100	+0.59
1973-2002	2840	+14.62

Table 8.25. Average annual growth rate in HAL as determined from the land cover classification.

Time period	Average annual HAL growth rate (%)
1973-1986	0.84
1986-1999	1.61
1999-2001	0.06
2001-2002	0.07
1973-2002	1.26

Table 8.26. Summary of population statistics for New Providence Island census years 1970-2000.

Census year	New Providence	% Total Bahamian Population	Average annual % growth rate New Providence	Average annual % growth rate The Bahamas
1970	101503	60.13	-	-
1980	135437	64.65	3.34	2.4
1990	172196	67.51	2.71	2.17
2000	210832	69.44	2.24	1.9
1970 to 2000			3.59	2.7

Chapter 9 Tables and Figures

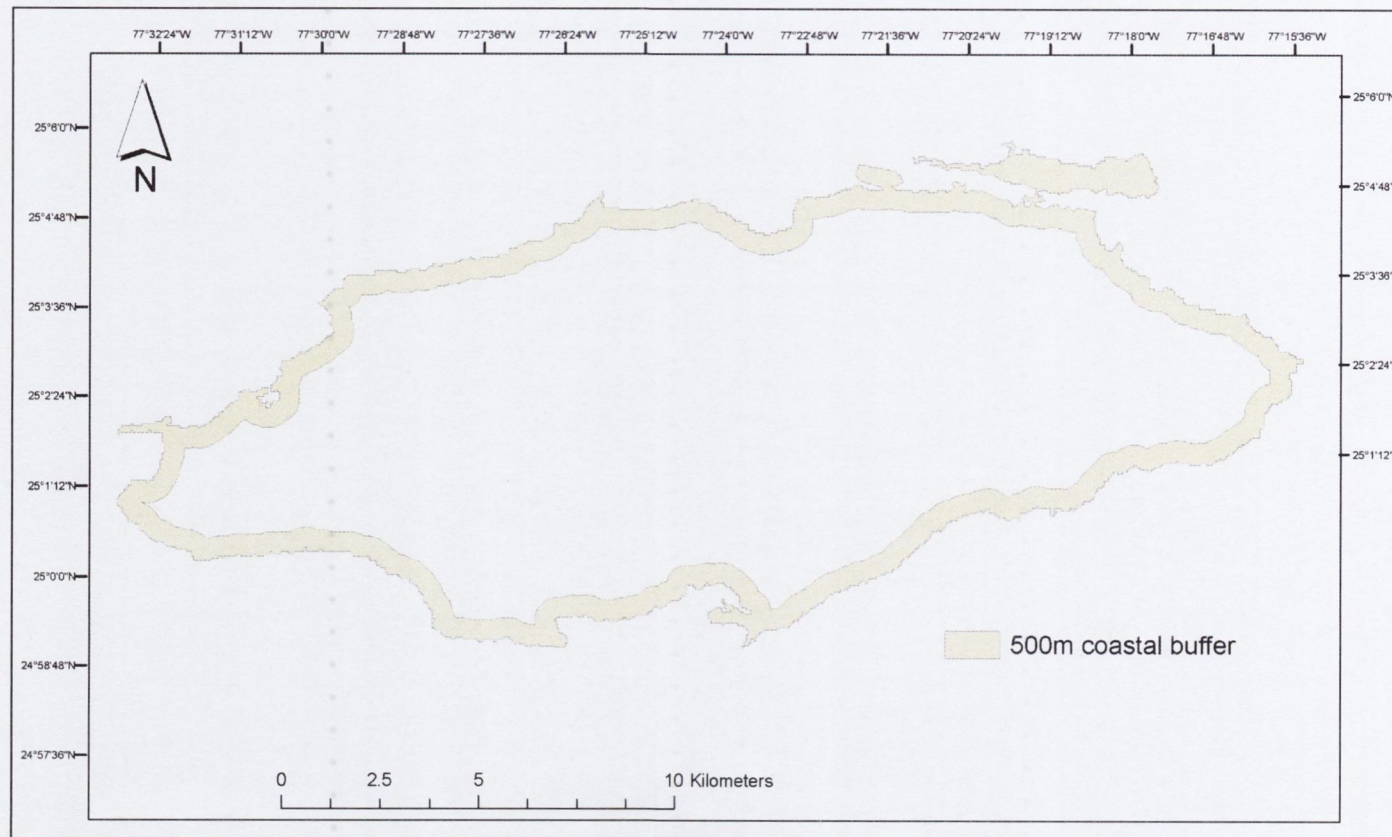


Figure 9.1. 500m coastal buffer mask used to subset the each land cover classification map in the time series.

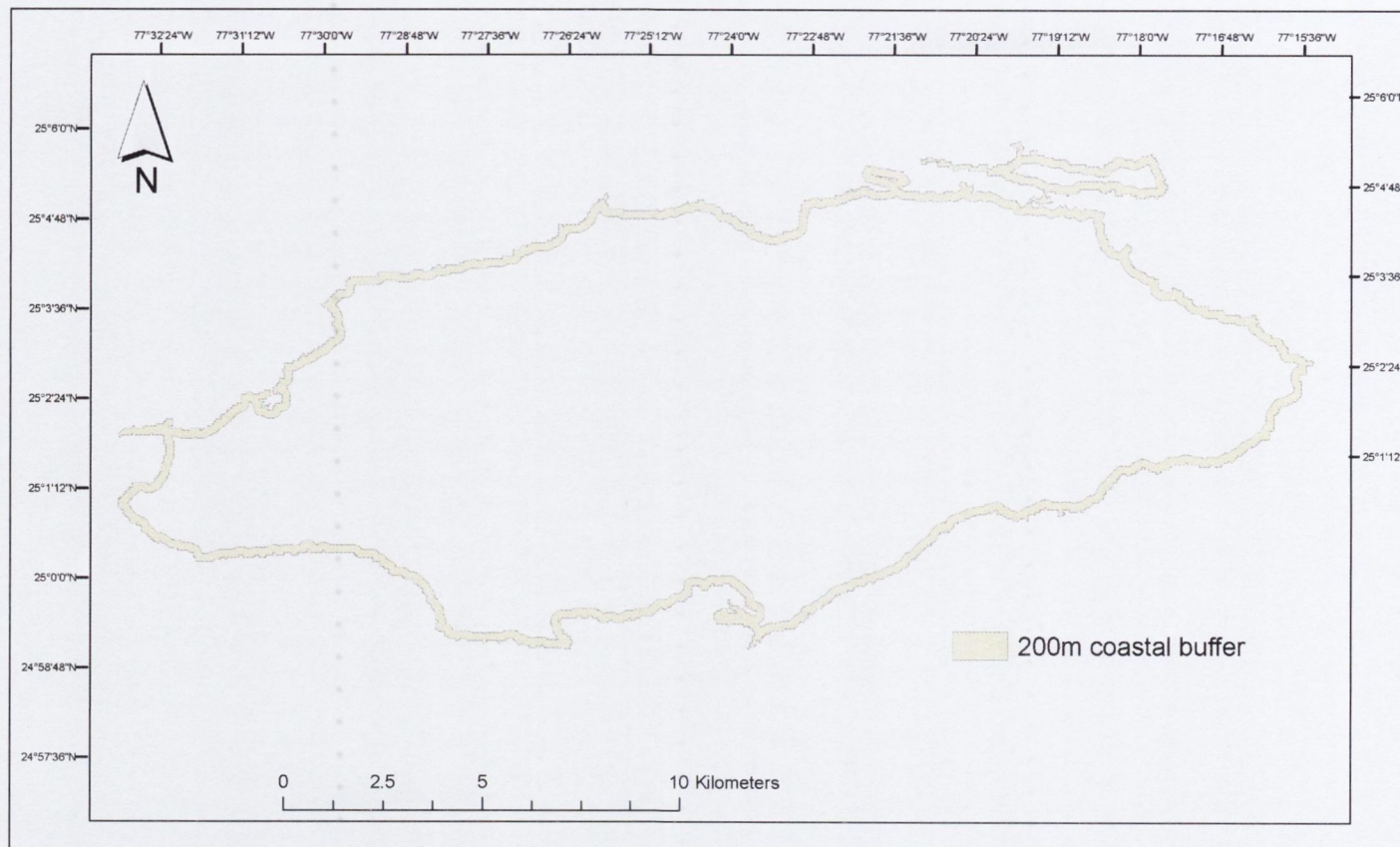


Figure 9.2. 200m coastal buffer mask used to subset the each land cover classification map in the time series.

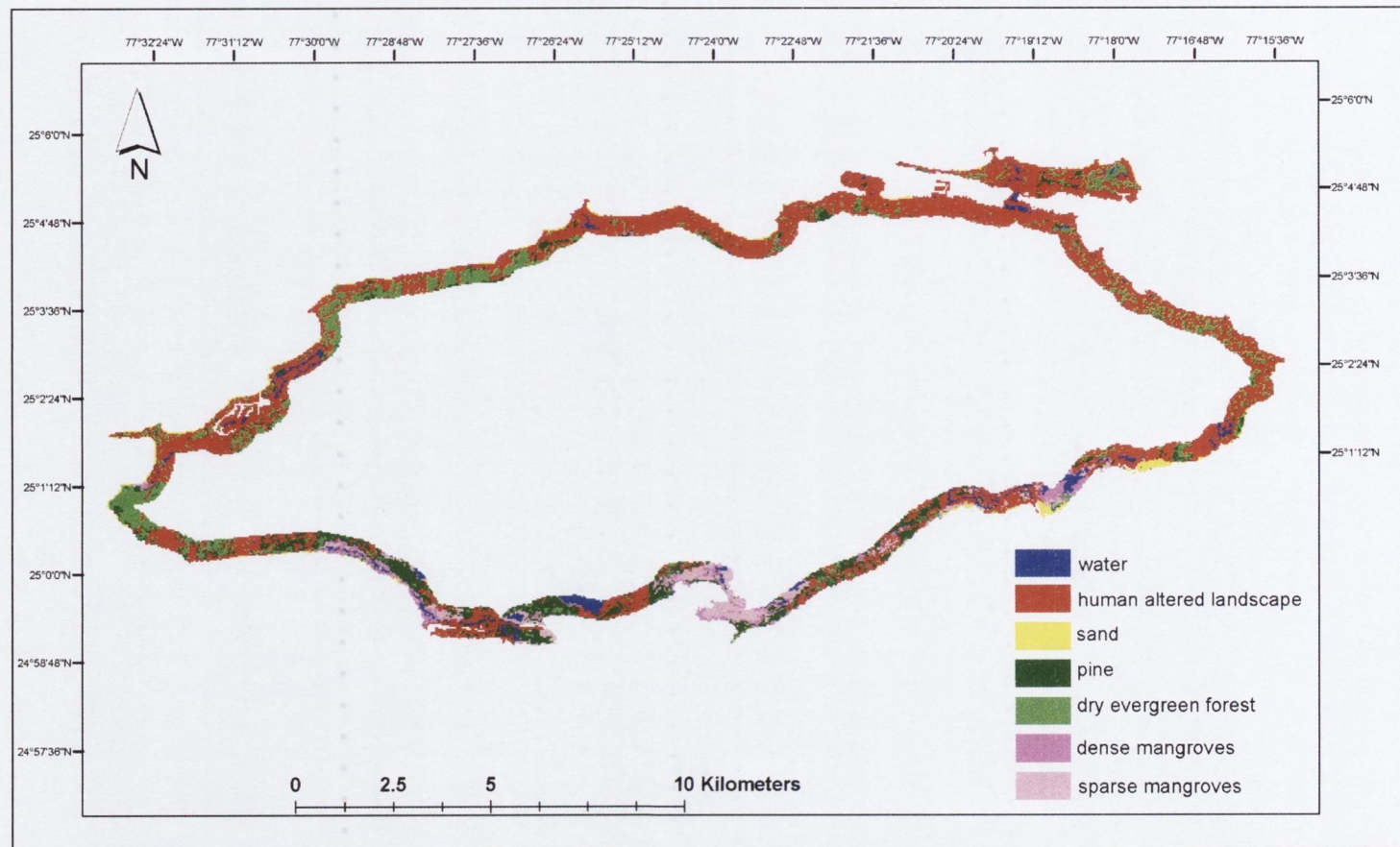


Figure 9.3. 500m coastal buffer land cover map, generated from the Landsat ETM+ 2002 classification.

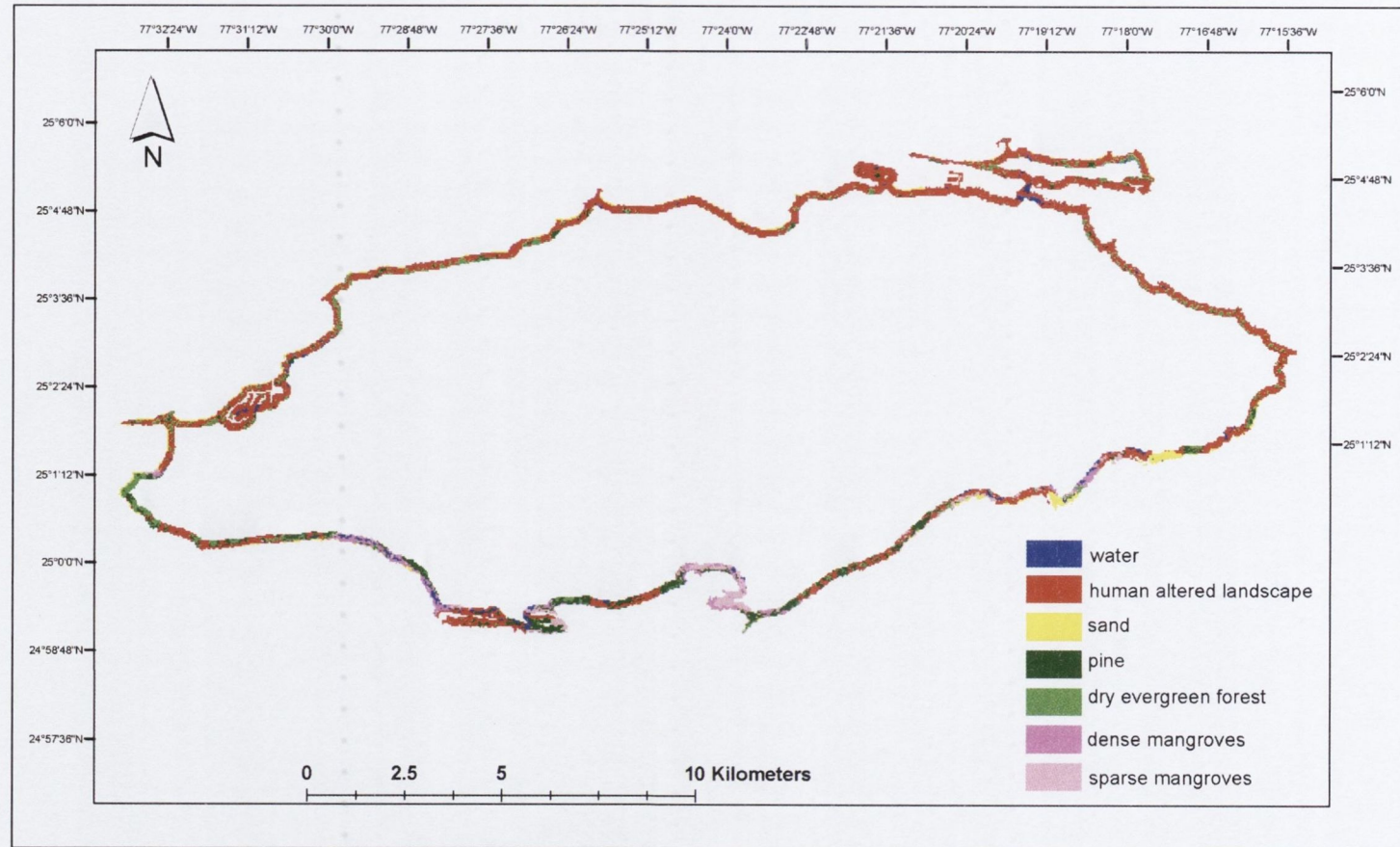


Figure 9.4. 200m coastal buffer land cover map generated from Landsat ETM+ 2002 classification.

Table 9.1. Scores for natural habitat extent and disturbance indices using remotely sensed images acquired in 1973, 1986, 1999, 2001 and 2002.

Spatial extent	Index Acronym	1973	1986	1999	2001	2002
Island wide	NLC	0.619	0.568	0.479	0.478	0.472
	HA	0.381	0.432	0.521	0.522	0.528
	HD	0.617	0.760	1.087	1.091	1.117
	NLI	-	0.900	0.761	0.764	0.753
	WI	-	0.574	0.630	0.856	0.632
	VI	-	0.951	0.782	0.754	0.772
	HI	-	1.109	1.341	1.351	1.364
Coastal zone (500m)	CNLC	0.591	0.550	0.459	0.466	0.452
	CA	0.409	0.450	0.541	0.534	0.548
	CD	0.691	0.818	1.176	1.147	1.214
	CLI		1.118	0.938	0.997	0.956
	CHI	-	1.323	1.597	1.654	1.679
Coastal zone (200m)	CNLC	0.687	0.534	0.436	0.445	0.421
	CA	0.313	0.466	0.564	0.555	0.579
	CD	0.457	0.873	1.290	1.250	1.370
	CLI		0.754	0.622	0.696	0.643
	CHI	-	1.440	1.760	1.910	1.940

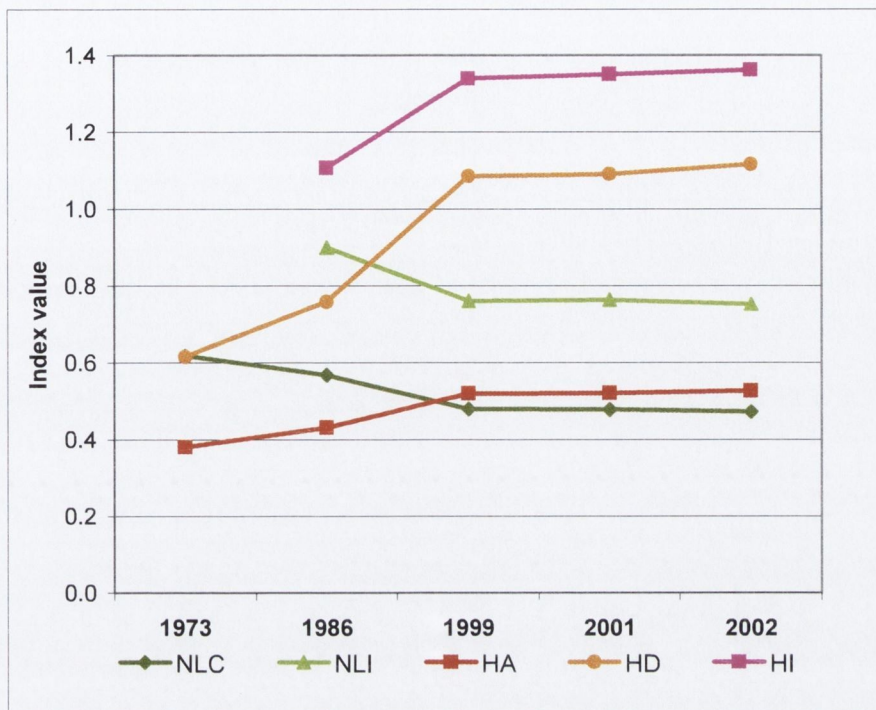


Figure 9.5. A trend analysis of changes in habitat extent (described by NLC and NLI) and disturbance (described by HA, HD and HI) indicator values between 1973 and 2002.

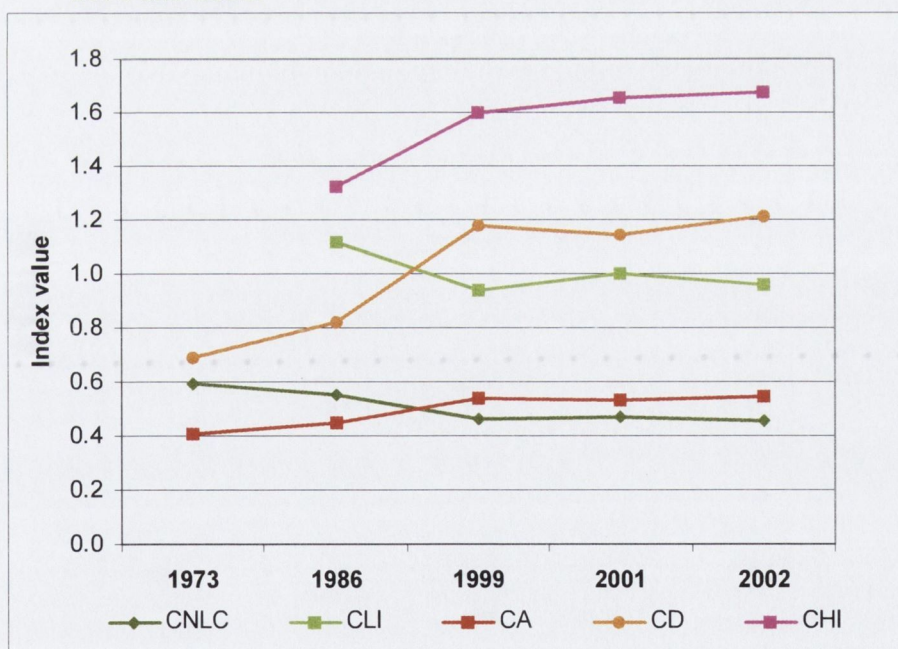


Figure 9.6. A trend analysis of changes in coastal habitat extent (described by CNLC and CLI) and disturbance (described by CA, CD and CHI) indicator values between 1973 and 2002 for a 500m area of coastal zone.

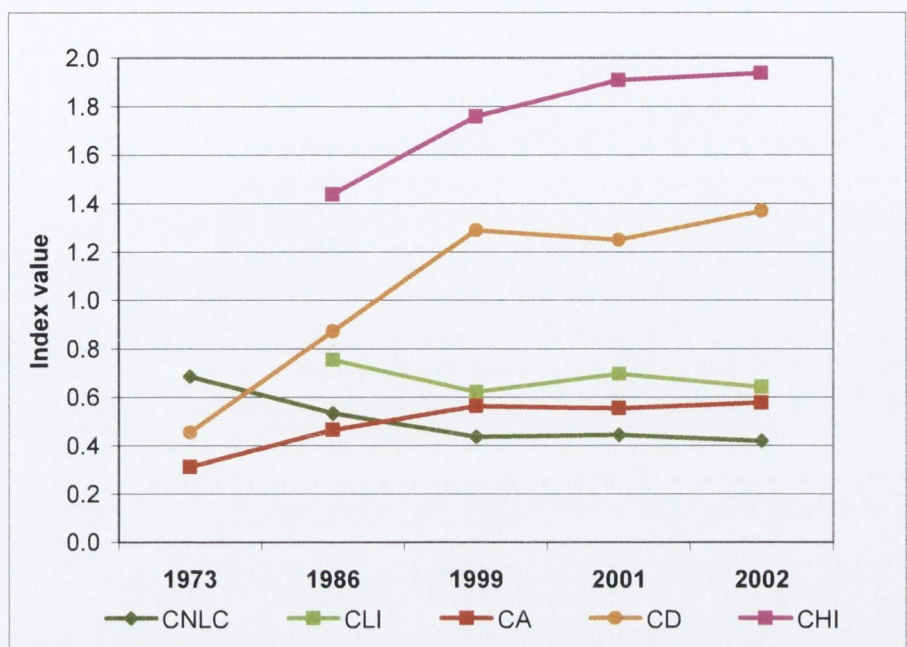
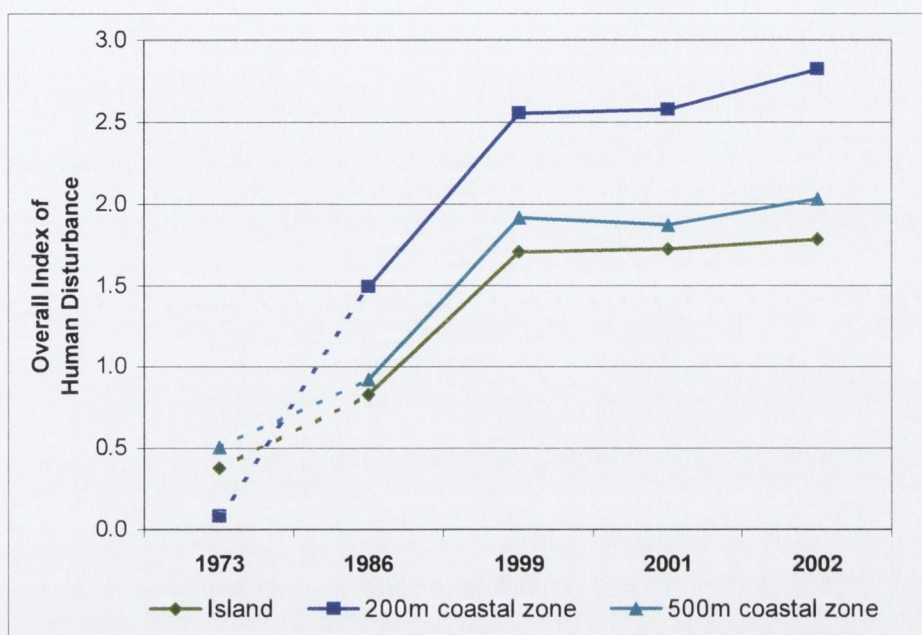


Figure 9.7. A trend analysis of changes in coastal habitat extent (described by CNLC and CLI) and disturbance (described by CA, CD and CHI) indicator values between 1973 and 2002 for a 200m area of coastal zone.

Table 9.2. Overall Index of Human Disturbance scores generated for the entire island and for a 500 and 200m coastal zone

Region	1973*	1986	1999	2001	2002
Island wide	0.380	0.832	1.708	1.722	1.783
500m coastal zone	0.509	0.923	1.917	1.872	2.033
200m coastal zone	0.083	1.491	2.556	2.574	2.825

*Computation of HDI for 1973 did not include indicator scores for NLI (CI) or HI (CI)



*HDI computation for 1973 did not include indicator values for NLI (CNLI) or HI (CI)

Figure 9.8. A trend analysis of changes in the Overall Index of Human Disturbance (HDI) for a 500m and 200m area of coastal zone.

Table 9.3. Results from a simple linear regression conducted using the values generated for 7 indices describing natural landscape extent and disturbance for each map year.

Metric Acronym	R	Significance value	R ²	B	p-value
NLC	0.993	0.000	0.986	-0.005	0.001
HA	0.993	0.000	0.986	0.005	0.001
HD	0.987	0.001	0.973	0.018	0.002
NLCI	0.990	0.005	0.980	-0.009	0.010
WI	0.549	0.301	0.226	0.009	0.451
VI	0.989	0.005	0.978	-0.012	0.000
HI	0.995	0.002	0.991	0.016	0.005
HDI	0.988	0.006	0.966	0.052	0.012

Table 9.4. Results from a simple linear regression conducted using the values generated for 7 indices describing habitat extent and disturbance for each map year.

Metric Acronym	500m Coastal Zone					200m Coastal Zone				
	R	Significance value	R ²	B	p-value	R	Significance value	R ²	B	p-value
CNLC	0.985	0.001	0.970	-0.005	0.002	0.988	0.001	0.975	-0.009	0.002
CA	0.985	0.001	0.970	0.005	0.002	0.988	0.001	0.975	0.009	0.002
CD	0.978	0.002	0.956	0.019	0.004	0.995	0.000	0.989	0.030	0.000
CI	0.915	0.043	0.837	-0.010	0.085	0.798	0.101	0.636	-0.006	0.202
CHI	0.999	0.000	0.998	0.022	0.001	0.982	0.009	0.965	0.030	0.018
CHDI	0.984	0.001	0.967	0.006	0.003	0.0995	0.000	0.991	0.091	0.000

Table 9.5. Spatial metric values generated within Fragstats v3.3 for each land cover map in the time series.

MAP YEAR	AREA										
	TA	NP	PD	LPI	TE	ED	LSI	AREA_MN	AREA_AM	AREA_SD	AREA_CV
1973	20451.32	2601	12.718	25.5785	2174379	106.3197	37.995	7.8629	2212.058	131.6484	1674.3048
1986	20038.29	7271	36.2855	31.9261	3189692	159.1798	56.2973	2.7559	3023.521	91.2414	3310.7413
1999	20087.27	8226	40.9513	45.7033	3148538	156.7429	55.5151	2.4419	4595.867	105.9094	4337.1281
2001	20203.42	9277	45.918	47.9146	3554976	175.9591	62.493	2.1778	4996.489	104.2909	4788.8269
2002	20166.62	7149	35.4497	42.1804	3054887	151.4823	53.7558	2.8209	4080.631	107.2525	3802.0648
SHAPE											
MAP YEAR						AREA					
	SHAPE_MN	SHAPE_AM	CONTIG_MN	CONTIG_AM	PAFRAC	GYRATE_MN	GYRATE_AM				
1973	1.36	12.1357	0.5419	0.8292	1.5131	68.5559	2027.0159				
1986	1.2689	21.461	0.196	0.7668	1.469	33.8301	2340.3566				
1999	1.2432	25.0242	0.1659	0.7733	1.4797	30.7229	3065.1429				
2001	1.2677	28.7485	0.1631	0.7498	1.5233	30.2391	3345.7109				
2002	1.2708	21.2204	0.1931	0.7828	1.4815	32.7825	2703.7672				
DIVERSITY											
MAP YEAR											
	SHDI	SIDI	MSIDI	SHEI	SIEI	MSIEI					
1973	1.3365	0.6968	1.1932	0.7459	0.8361	0.666					
1986	1.2324	0.6649	1.0933	0.6878	0.7979	0.6102					
1999	1.1933	0.6316	0.9986	0.666	0.7579	0.5573					
2001	1.2207	0.6351	1.0081	0.6813	0.7621	0.5627					
2002	1.1792	0.6241	0.9785	0.6581	0.7489	0.5461					
CONTAGION											
MAP YEAR											
	CONTAG	PLADJ	IJI	DIVISION	MESH	SPLIT	AI				
1973	48.0675	85.7947	64.7835	0.8918	2212.058	9.2454	86.1492				
1986	46.8642	78.5941	55.5742	0.8491	3023.521	6.6275	78.9026				
1999	48.4384	78.9862	57.5772	0.7712	4595.867	4.3707	79.2874				
2001	45.9302	76.4284	61.4854	0.7527	4996.489	4.0435	76.7208				
2002	49.1627	79.8394	58.965	0.7977	4080.631	4.942	80.1451				

Table 9.6. Results from a simple linear regression conducted using a time series of 31 metric values generated for the entire island.

Metric Category	Metric Acronym	R	Significance value	R ²	B	p-value	Direction
AREA	TA	0.609	0.138	0.371	-7.796	0.275	
	NP	0.881	0.024	0.776	179.667	0.049	increasing
	PD	0.878	0.025	0.772	0.895	0.050	increasing
	LPI	0.956	0.005	0.914	0.729	0.011	increasing
	TE	0.824	0.043	0.678	33675.12	0.005	increasing
	ED	0.821	0.044	0.674	1.708	0.089	
	LSI	0.823	0.044	0.677	0.599	0.087	
	AREA_MN	0.874	0.026	0.764	-0.167	0.052	
	AREA_AM	0.940	0.009	0.883	86.142	0.018	increasing
	AREA_SD	0.551	0.168	0.304	-0.645	0.336	
	AREA_CV	0.933	0.01	0.871	89.695	0.031	increasing
	GYRATE_MN	0.885	0.023	0.784	-1.164	0.046	decreasing
	GYRATE_AM	0.877	0.026	0.768	37.258	0.050	increasing
SHAPE	SHAPE_MN	0.851	0.034	0.724	-0.003	0.068	
	SHAPE_AM	0.857	0.032	0.735	0.423	0.063	
	CONTIG_MN	0.879	0.025	0.773	-0.011	0.050	decreasing
	CONTIG_AM	0.768	0.065	0.589	-0.002	0.130	
	PAFRAC	0.148	0.406	0.022	0.000	0.813	
DIVERSITY	SHDI	0.932	0.011	0.868	-0.005	0.021	decreasing
	SIDI	0.993	0.000	0.987	-0.002	0.001	decreasing
	MSIDI	0.994	0.000	0.988	-0.007	0.001	decreasing
	SHEI	0.932	0.011	0.868	-0.003	0.021	decreasing
	SIEI	0.993	0.000	0.987	-0.003	0.001	decreasing
	MSIEI	0.994	0.000	0.988	-0.004	0.001	decreasing
CONTAGION	CONTAG	0.03	0.481	0.001	0.003	0.962	
	PLADJ	0.810	0.048	0.656	-0.227	0.097	
	IJI	0.436	0.232	0.190	-0.124	0.463	
	DIVISION	0.942	0.008	0.887	-0.004	0.017	decreasing
	MESH	0.940	0.009	0.883	86.142	0.018	increasing
	SPLIT	0.976	0.002	0.953	-0.167	0.004	decreasing
	AI	0.811	0.048	0.657	-0.299	0.096	

Table 9.7. Spatial metric values generated within Fragstats v3.3 from 500m coastal buffer zones for each year in the time series.

MAP YEAR	AREA										
	TA	NP	PD	LPI	TE	ED	LSI	AREA_MN	AREA_AM	AREA_SD	AREA_CV
1973	4185.362	954	22.7937	7.3999	681606	162.8547	26.3392	4.3872	58.8414	15.4564	352.3089
1986	4022.1	2090	51.9629	12.4843	933831	232.175	36.7332	1.9244	130.1884	15.7111	816.3925
1999	4007.885	2181	54.4177	28.5593	892363.5	222.652	35.1809	1.8376	372.6657	26.1045	1420.55
2001	4219.07	2364	56.0313	33.6773	1043756	247.3899	40.1568	1.7847	507.1492	30.0322	1682.743
2002	4165.949	2028	48.6804	32.5781	929727	223.1729	36.0066	2.0542	496.4805	31.8694	1551.414

MAP YEAR	SHAPE				AREA		
			CONTIG_MN	CONTIG_AM	PAFRAC	GYRATE_MN	GYRATE_AM
1973	75.3379	422.3407	0.5319	0.7742	1.4666	75.3379	422.3407
1986	41.8916	735.6852	0.2237	0.6976	1.4826	41.8916	735.6852
1999	37.5035	1438.401	0.1839	0.7162	1.4955	37.5035	1438.401
2001	37.9239	1915.665	0.1846	0.6875	1.539	37.9239	1915.665
2002	39.2436	1910.97	0.2025	0.7173	1.4962	39.2436	1910.97

DIVERSITY						
MAP YEAR	SHDI	SIDI	MSIDI	SHEI	SIEI	MSIEI
1973	1.5479	0.756	1.4105	0.8639	0.9072	0.7872
1986	1.3604	0.6843	1.1531	0.7593	0.8212	0.6436
1999	1.2832	0.6231	0.9757	0.7162	0.7477	0.5446
2001	1.3108	0.6334	1.0034	0.7316	0.7601	0.56
2002	1.2759	0.6178	0.9617	0.7121	0.7413	0.5367

CONTAGION							
MAP YEAR	CONTAG	PLADJ	IJI	DIVISION	MESH	SPLIT	AI
1973	41.3816	81.1462	85.7318	0.9859	58.8414	71.1295	81.959
1986	41.8576	72.3141	76.2447	0.9676	130.1884	30.8945	72.9922
1999	45.3095	73.821	77.4657	0.907	372.6657	10.7546	74.4845
2001	42.869	70.6977	76.2282	0.8798	507.1492	8.3192	71.3248
2002	45.3661	73.894	75.5597	0.8808	496.4805	8.391	74.5566

Table 9.8. Spatial metric values generated within Fragstats v3.3 from 200m coastal buffer zones for each year in the time series.

MAP YEAR						AREA						
	TA	NP	PD	LPI	TE	ED	LSI	AREA_MN	AREA_AM	AREA_SD	AREA_CV	
1973	1983.027	766	38.6278	5.546	464122.5	234.0475	26.0144	2.5888	18.1827	6.3537	245.43	
1986	1899.447	1347	70.9154	10.31	576640.5	303.5834	33.0605	1.4101	37.7962	7.163	507.9694	
1999	1909.112	1347	70.5563	30.2672	556690.5	291.5965	31.8127	1.4173	190.0514	16.3509	1153.6607	
2001	2092.6	1437	68.6706	26.309	639369	305.5381	34.8354	1.4562	164.9556	15.4302	1059.6034	
2002	2040.778	1264	61.9372	29.608	573363	280.9531	31.6321	1.6145	200.8126	17.9336	1110.7548	
SHAPE						AREA						
MAP YEAR			CONTIG_MN	CONTIG_AM	PAFRAC	GYRATE_MN	GYRATE_AM					
1973	67.5536	267.2234	0.4961	0.7109	1.4394	67.5536	267.2234					
1986	44.9976	476.9405	0.2426	0.6366	1.4793	44.9976	476.9405					
1999	40.5421	1332.3162	0.1968	0.6585	1.5034	40.5421	1332.3162					
2001	41.5484	1392.9896	0.1938	0.6459	1.5335	41.5484	1392.9896					
2002	42.9707	1754.4942	0.2111	0.6753	1.4981	42.9707	1754.4942					
DIVERSITY												
MAP YEAR	SHDI	SIDI	MSIDI	SHEI	SIEI	MSIEI						
1973	1.6292	0.7796	1.5125	0.9093	0.9356	0.8441						
1986	1.4209	0.6923	1.1786	0.793	0.8308	0.6578						
1999	1.3149	0.6194	0.9659	0.7339	0.7432	0.5391						
2001	1.3326	0.6266	0.9852	0.7437	0.752	0.5498						
2002	1.283	0.6019	0.921	0.716	0.7223	0.514						
CONTAGION												
MAP YEAR	CONTAG	PLADJ	IJI	DIVISION	MESH	SPLIT	AI					
1973	35.2893	75.6943	86.7616	0.9908	18.1827	109.061	76.8339					
1986	39.4698	66.9382	78.4646	0.9801	37.7962	50.255	67.8721					
1999	40.9405	68.6649	81.3699	0.9005	190.0514	10.0452	69.5619					
2001	42.1641	67.0399	77.9796	0.9212	164.9556	12.6858	67.891					
2002	42.5398	70.1791	78.5168	0.9016	200.8126	10.1626	71.0784					

Table 9.9. Results from a simple linear regression conducted using a time series of 31 metric values generated for a 500m coastal buffer.

Metric Category	Metric Acronym	R	Significance value	R ²	B	p-value	Direction
AREA	TA	0.018	0.489	0.000	-0.141	0.977	
	NP	0.870	0.028	0.756	38.662	0.055	
	PD	0.847	0.035	0.717	0.926	0.070	
	LPI	0.970	0.003	0.941	0.942	0.006	increasing
	TE	0.826	0.042	0.683	8755.356	0.003	increasing
	ED	0.813	0.047	0.661	2.093	0.094	
	LSI	0.824	0.043	0.679	0.338	0.086	
	AREA_MN	0.855	0.032	0.732	-0.076	0.065	
	AREA_SD	0.920	0.013	0.846	0.574	0.027	increasing
	AREA_CV	0.989	0.001	0.978	44.425	0.001	increasing
	AREA_AM	0.953	0.006	0.909	15.835	0.012	increasing
	GYRATE_MN	0.899	0.019	0.808	-1.169	0.038	decreasing
	GYRATE_AM	0.958	0.005	0.917	52.164	0.010	increasing
SHAPE	SHAPE_MN	0.852	0.033	0.727	-0.002	0.067	
	SHAPE_AM	0.970	0.003	0.940	0.216	0.006	increasing
	CONTIG_MN	0.898	0.019	0.806	-0.011	0.039	decreasing
	CONTIG_AM	0.738	0.077	0.544	-0.002	0.155	
	PAFRAC	0.761	0.068	0.879	0.002	0.135	
DIVERSITY	SHDI	0.957	0.005	0.916	-0.009	0.011	decreasing
	SIDI	0.990	0.001	0.980	-0.005	0.001	decreasing
	MSIDI	0.986	0.001	0.973	-0.015	0.002	decreasing
	SHEI	0.957	0.005	0.916	-0.005	0.011	decreasing
	SIEI	0.990	0.001	0.980	-0.006	0.001	decreasing
	MSIEI	0.986	0.001	0.973	-0.008	0.002	decreasing
CONTAGION	CONTAG	0.803	0.051	0.645	0.121	0.101	
	PLADJ	0.788	0.057	0.621	-0.252	0.113	
	IJI	0.851	0.034	0.724	-0.288	0.067	
	DIVISION	0.961	0.005	0.923	-0.004	0.009	decreasing
	MESH	0.953	0.006	0.909	15.835	0.012	increasing
	SPLIT	0.983	0.001	0.966	-2.120	0.003	decreasing
	AI	0.791	0.056	0.625	-0.257	0.111	

Table 9.10. Results from a simple linear regression conducted using a time series of 31 metric values generated for a 200m coastal buffer.

Metric Category	Metric Acronym	R	Significance value	R ²	B	p-value	Direction
AREA	TA	0.370	0.270	0.137	2.466	0.539	
	NP	0.831	0.041	0.690	17.163	0.082	
	PD	0.747	0.074	0.558	0.813	0.018	increasing
	LPI	0.958	0.005	0.918	0.889	0.010	increasing
	TE	0.805	0.050	0.648	4059.631	0.100	
	ED	0.718	0.086	0.515	1.674	0.172	
	LSI	0.775	0.062	0.601	0.205	0.123	
	AREA_MN	0.798	0.053	0.636	-0.032	0.106	
	AREA_SD	0.938	0.009	0.880	0.409	0.018	increasing
	AREA_CV	0.978	0.002	0.956	32.216	0.004	increasing
	AREA_AM	0.943	0.008	0.890	6.587	0.016	increasing
	GYRATE_MN	0.906	0.017	0.821	-0.819	0.034	decreasing
	GYRATE_AM	0.950	0.007	0.903	48.539	0.013	increasing
SHAPE	SHAPE_MN	0.615	0.135	0.378	-0.001	0.269	
	SHAPE_AM	0.990	0.001	0.981	0.160	0.007	increasing
	CONTIG_MN	0.917	0.014	0.840	-0.009	0.029	decreasing
	CONTIG_AM	0.557	0.165	0.311	-0.001	0.329	
	PAFRAC	0.916	0.014	0.840	0.003	0.029	increasing
DIVERSITY	SHDI	0.977	0.002	0.955	-0.11	0.004	decreasing
	SIDI	0.993	0.000	0.985	-0.006	0.001	decreasing
	MSIDI	0.988	0.001	0.976	-0.019	0.002	decreasing
	SHEI	0.977	0.002	0.955	-0.006	0.004	decreasing
	SIEI	0.993	0.000	0.985	-0.007	0.001	decreasing
	MSIEI	0.988	0.001	0.976	-0.011	0.002	decreasing
CONTAGION	CONTAG	0.980	0.002	0.961	0.230	0.003	increasing
	PLADJ	0.686	0.101	0.470	-0.197	0.201	
	IJI	0.777	0.061	0.603	-0.229	0.122	
	DIVISION	0.934	0.010	0.872	-0.003	0.020	decreasing
	MESH	0.943	0.008	0.890	6.587	0.016	increasing
	SPLIT	0.987	0.001	0.975	-3.392	0.002	decreasing
	AI	0.695	0.096	0.483	-0.206	0.193	

Table 9.11. A comparison of the statistically significant ($p\text{-value} \leq 0.05$) trends in spatial metric values.

Metric Category	Metric Acronym	Island	500m	200m	Direction
AREA	NP	0.049	0.055	0.082	increasing
	PD	0.050	0.070	0.018	increasing
	LPI	0.011	0.006	0.010	increasing
	TE	0.005	0.003	0.100	increasing
	AREA_AM	0.018	0.012	0.016	increasing
	AREA_SD	0.336	0.027	0.018	increasing
	AREA_CV	0.031	0.001	0.004	increasing
	GYRATE_MN	0.046	0.038	0.034	decreasing
	GYRATE_AM	0.050	0.010	0.013	increasing
SHAPE	SHAPE_AM	0.068	0.006	0.007	increasing
	CONTIG_MN	0.050	0.039	0.029	decreasing
	PAFRAC	0.813	0.135	0.029	increasing
DIVERSITY	SHDI	0.021	0.011	0.004	decreasing
	SIDI	0.001	0.001	0.001	decreasing
	MSIDI	0.001	0.002	0.002	decreasing
	SHEI	0.021	0.011	0.004	decreasing
	SIEI	0.001	0.001	0.001	decreasing
	MSIEI	0.001	0.002	0.002	decreasing
CONTAGION	CONTAG	0.962	0.101	0.003	increasing
	DIVISION	0.017	0.009	0.020	decreasing
	MESH	0.018	0.012	0.016	increasing
	SPLIT	0.004	0.003	0.002	decreasing

Table 9.12. Comparative analysis of AREA spatial metric correlation values.

LANDSCAPE												
	TA	NP	PD	LPI	TE	ED	LSI	A_MN	A_AM	A_SD	A_CV	G_MN
TA												
NP	-0.788											
PD	-0.795	1.000										
LPI	-0.504	0.882	0.878									
TE	-0.773	0.985	0.985	0.814								
ED	-0.790	0.985	0.985	0.807	1.000							
LSI	-0.782	0.985	0.985	0.811	1.000	1.000						
A_MN	0.888	-0.973	-0.974	-0.813	-0.957	-0.963	-0.960					
A_AM	-0.503	0.896	0.893	0.997	0.836	0.829	0.833	-0.816				
A_SD	0.949	-0.799	-0.805	(-0.444)	-0.838	-0.850	-0.844	0.880	(-0.459)			
A_CV	-0.680	0.979	0.977	0.959	0.941	0.938	0.940	-0.927	0.968	(-0.664)		
G_MN	0.890	-0.965	-0.967	-0.817	-0.945	-0.951	-0.948	0.999	-0.817	0.871	-0.924	
G_AM	-0.441	0.879	0.875	0.974	0.827	0.818	0.822	-0.768	0.988	(-0.418)	0.952	-0.763

500m COASTAL BUFFER												
	TA	NP	PD	LPI	TE	ED	LSI	A_MN	A_A M	A_SD	A_CV	G_MN
TA												
NP	-0.276											
PD	-0.359	0.996										
LPI	0.186	0.758	0.720									
TE	-0.022	0.954	0.928	0.749								
ED	-0.187	0.983	0.971	0.703	0.986							
LSI	-0.099	0.971	0.952	0.731	0.997	0.996						
A_MN	0.372	-0.989	-0.994	-0.719	-0.919	-0.964	-0.944					
A_AM	0.273	0.726	0.681	0.994	0.745	0.685	0.721	-0.683				
A_SD	(0.319)	0.628	0.581	0.979	0.643	0.577	0.616	-0.592	0.989			
A_CV	0.097	(0.850)	(0.817)	0.988	(0.837)	(0.804)	(0.826)	(-0.814)	0.977	0.941		
G_MN	0.339	-0.982	-0.984	-0.774	-0.907	-0.947	-0.930	0.995	-0.740	-0.660	(-0.857)	
G_AM	0.268	0.743	0.698	0.990	0.768	0.709	0.744	-0.704	0.998	0.984	0.978	-0.759

200m COASTAL BUFFER												
	TA	NP	PD	LPI	TE	ED	LSI	A_MN	A_A M	A_SD	A_CV	G_MN
TA												
NP	0.069											
PD	-0.143	0.977										
LPI	0.334	0.676	0.601									
TE	0.395	0.931	(0.839)	0.619								
ED	-0.001	0.983	0.975	0.530	0.919							
LSI	0.199	0.977	0.926	0.584	0.979	0.980						
A_MN	0.080	-0.985	-0.995	-0.652	(-0.859)	-0.971	-0.934					
A_AM	0.387	0.618	0.533	0.996	0.579	0.465	0.530	-0.591				
A_SD	(0.437)	0.593	0.498	0.988	0.574	0.438	0.514	-0.561	0.998			
A_CV	0.324	(0.774)	(0.671)	0.995	(0.689)	(0.610)	(0.661)	(-0.717)	0.984	0.974		
G_MN	-0.050	-0.973	-0.956	-0.795	(-0.866)	-0.922	-0.911	0.977	-0.747	-0.723	(-0.846)	
G_AM	0.494	0.620	0.512	0.967	0.627	0.472	0.559	-0.583	0.980	0.989	0.957	-0.741

Table 9.13. Comparative analysis of SHAPE spatial metric correlation values.

	LANDSCAPE		
	S_MN	S_AM	Contig_MN
S_MN			
S_AM	-0.871		
Contig_MN	0.977	-0.906	
Contig_AM	0.870	-0.956	0.932
Pafrac	0.495	(-0.020)	(0.412)
	500m COASTAL BUFFER		
	S_MN	S_AM	Contig_MN
S_MN			
S_AM	-0.713		
Contig_MN	(0.880)	(-0.855)	
Contig_AM	0.624	(-0.774)	0.918
Pafrac	-0.364	(0.861)	(-0.665)
	200m COASTAL BUFFER		
	S_MN	S_AM	Contig_MN
S_MN			
S_AM	-0.672		
Contig_MN	(0.455)	(-0.860)	
Contig_AM	-0.056	(-0.450)	(0.827)
Pafrac	-0.267	-0.886	-0.890

Table 9.14. Comparative analysis of DIVERSITY spatial metric correlation values.

	LANDSCAPE				
	SHDI	SIDI	MSIDI	SHEI	SIEI
SHDI					
SIDI	0.956				
MSIDI	0.961	1.000			
SHEI	1.000	0.956	0.961		
SIEI	0.956	1.000	1.000	0.956	
MSIEI	0.961	1.000	1.000	0.961	1.000
	500m COASTAL BUFFER				
	SHDI	SIDI	MSIDI	SHEI	SIEI
SHDI					
SIDI	0.983				
MSIDI	0.991	0.999			
SHEI	1.000	0.983	0.991		
SIEI	0.983	1.000	0.998	0.983	
MSIEI	0.991	0.999	1.000	0.991	0.999
	200m COASTAL BUFFER				
	SHDI	SIDI	MSIDI	SHEI	SIEI
SHDI					
SIDI	0.993				
MSIDI	0.998	0.997			
SHEI	1.000	0.993	0.998		
SIEI	0.993	1.000	0.997	0.993	
MSIEI	0.998	0.997	1.000	0.998	0.997

Table 9.15. Comparative analysis of CONTAGION spatial metric correlation values.

	LANDSCAPE					
	contag	pladj	iji	division	mesh	split
Contag						
Pladj	0.477					
Iji	-0.026	(0.620)				
Division	0.177	0.827	0.298			
Mesh	-0.178	-0.821	-0.282	-1.000		
Split	(0.124)	0.885	(0.477)	0.977	-0.974	
ai	0.476	1.000	(0.621)	0.828	-0.822	0.886
	500m COASTAL BUFFER					
	contag	pladj	iji	division	mesh	
Contag						
Pladj	-0.349					
Iji	-0.554	0.941				
Division	-0.764	0.657	0.707			
Mesh	0.743	-0.654	-0.700	-0.999		
Split	(-0.751)	0.873	0.923	(0.898)	(-0.888)	
ai	-0.353	1.000	0.942	0.660	-0.657	0.875
	200m COASTAL BUFFER					
	contag	pladj	iji	division	mesh	
Contag						
Pladj	-0.763					
Iji	-0.882	0.904				
Division	-0.853	0.425	0.509			
Mesh	0.868	-0.426	-0.531	-0.997		
Split	-0.997	0.766	(0.812)	0.902	-0.904	
ai	-0.771	1.000	0.907	0.436	-0.438	0.775

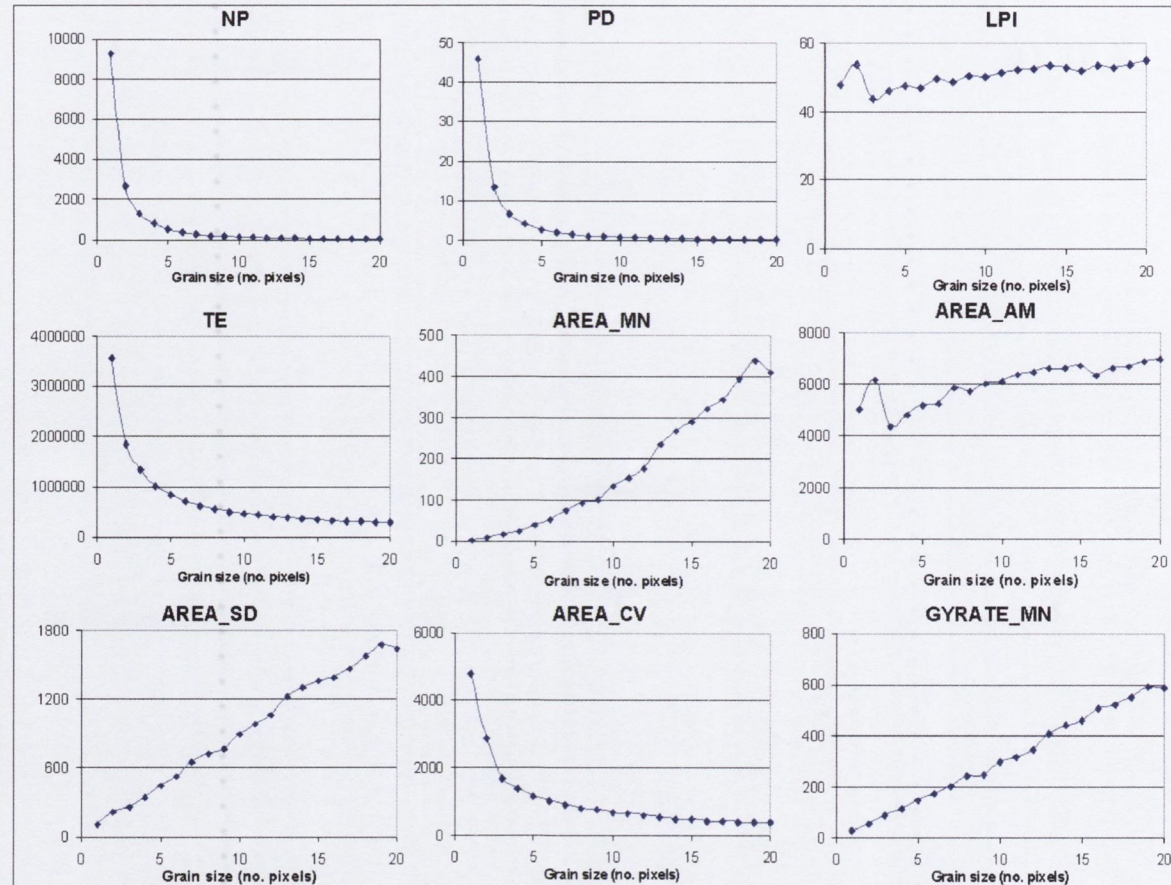


Figure 9.9. Response curves of AREA spatial metrics to changing spatial scale generated from the 2001 land cover maps with spatial resolution ranging from 1x1 to 20 x 20 pixels.

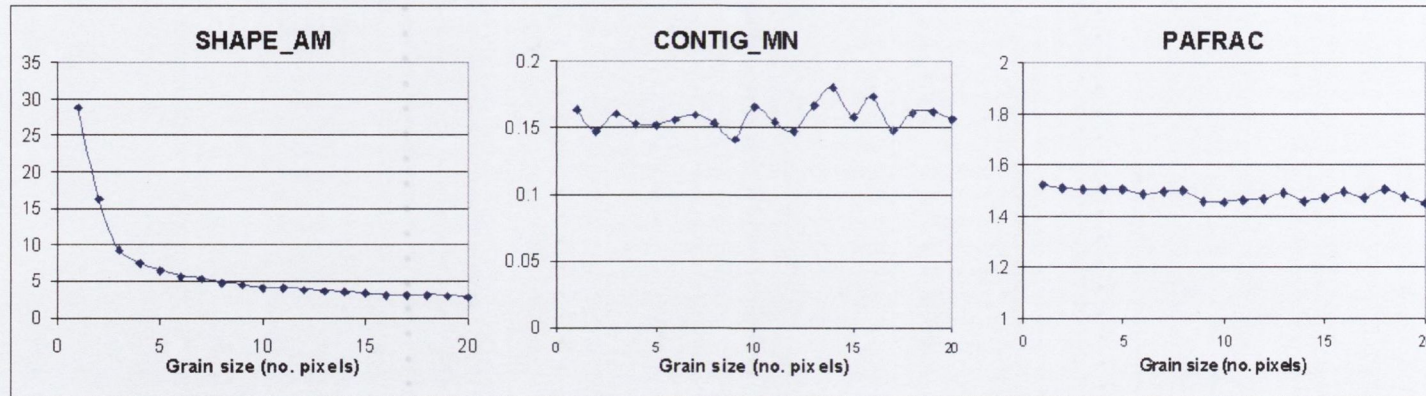


Figure 9.10. Response curves of SHAPE spatial metrics to changing spatial scale generated from the 2001 land cover maps with spatial resolution ranging from 1x1 to 20 x 20 pixels.

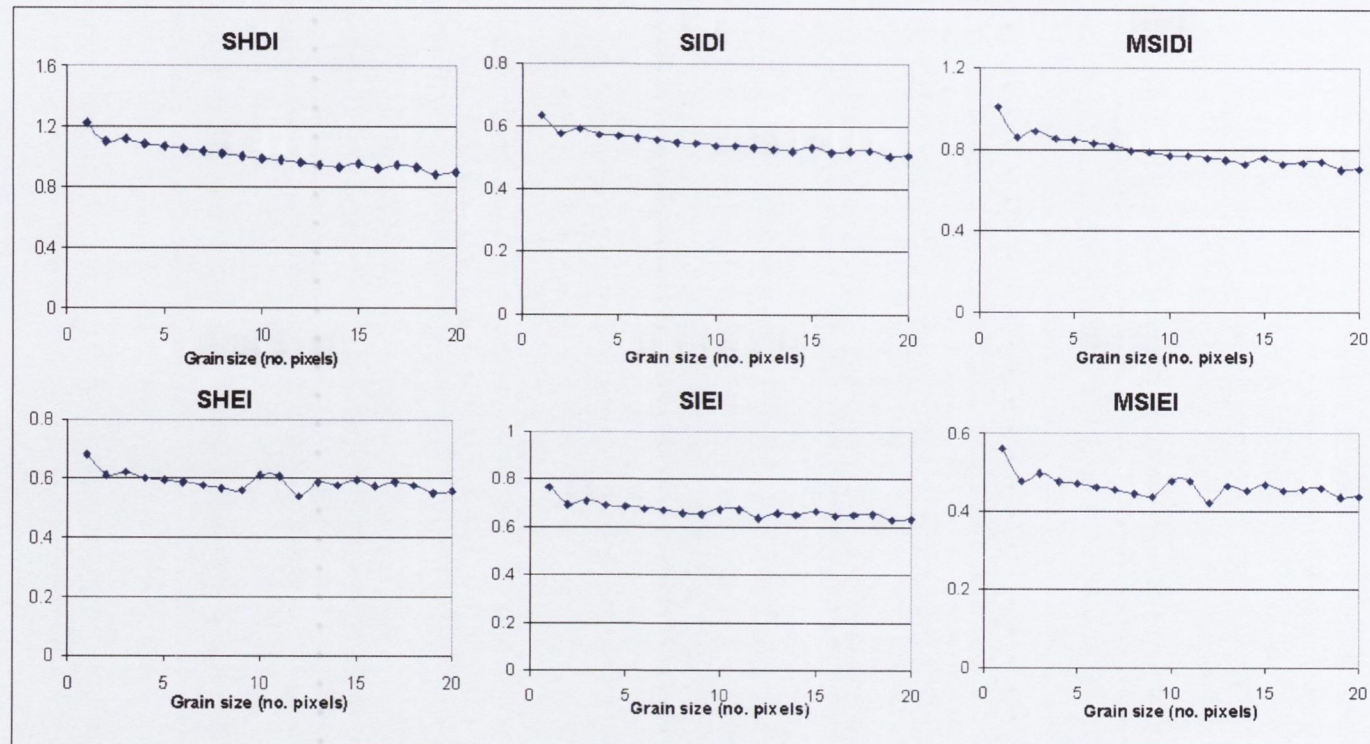


Figure 9.11. Response curves of DIVERSITY spatial metrics to changing spatial scale generated from the 2001 land cover maps with spatial resolution ranging from 1x1 to 20 x 20 pixels.

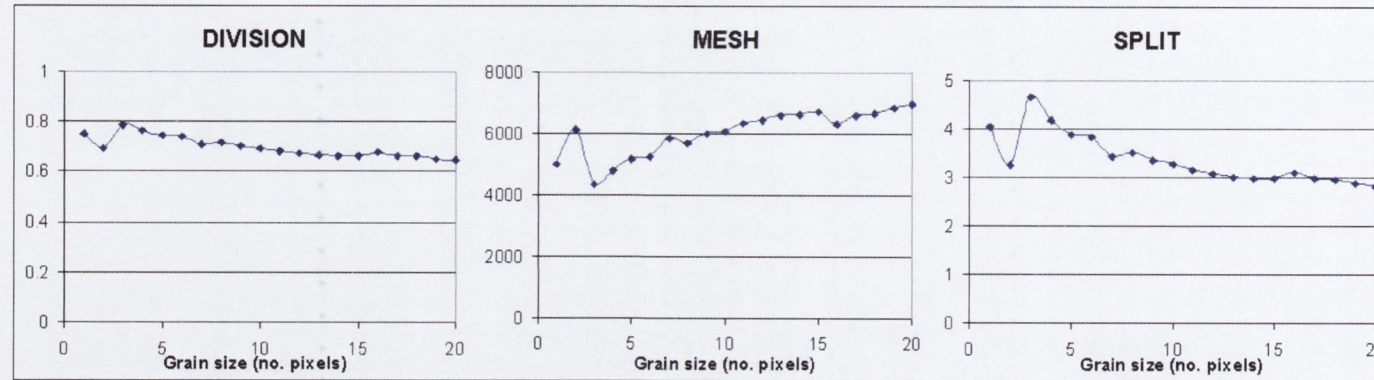


Figure 9.12. Response curves of CONFIGURATION spatial metrics to changing spatial scale generated from the New Providence 2001 land cover maps with spatial resolution ranging from 1x1 to 20 x 20 pixels.

Chapter 10 Tables and Figures

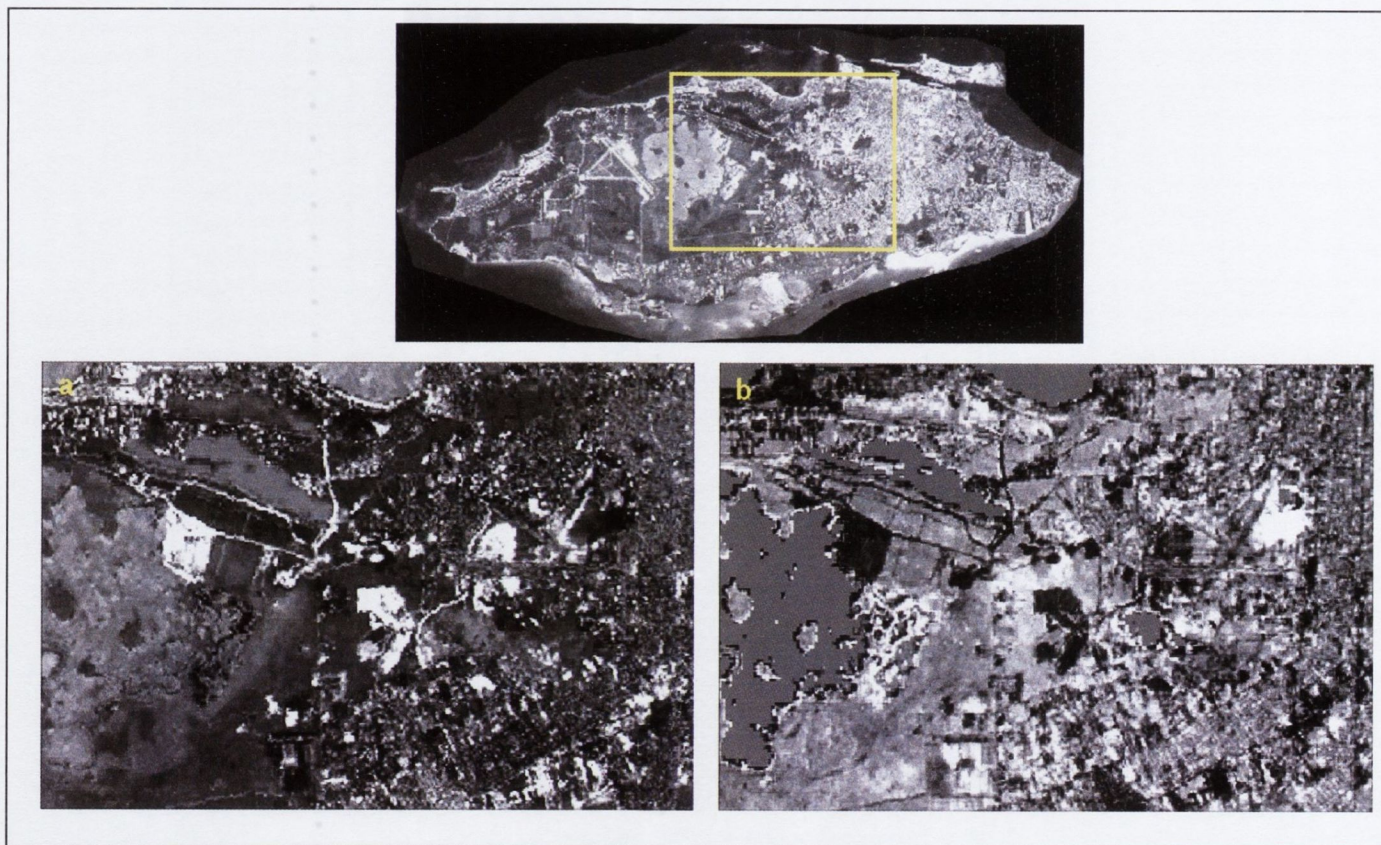


Figure 10.1. Comparison of the success of a) brightness PC3 and b) NDVI PC2 generated following multitemporal PCA to highlight landscape change between 1973 and 2002.

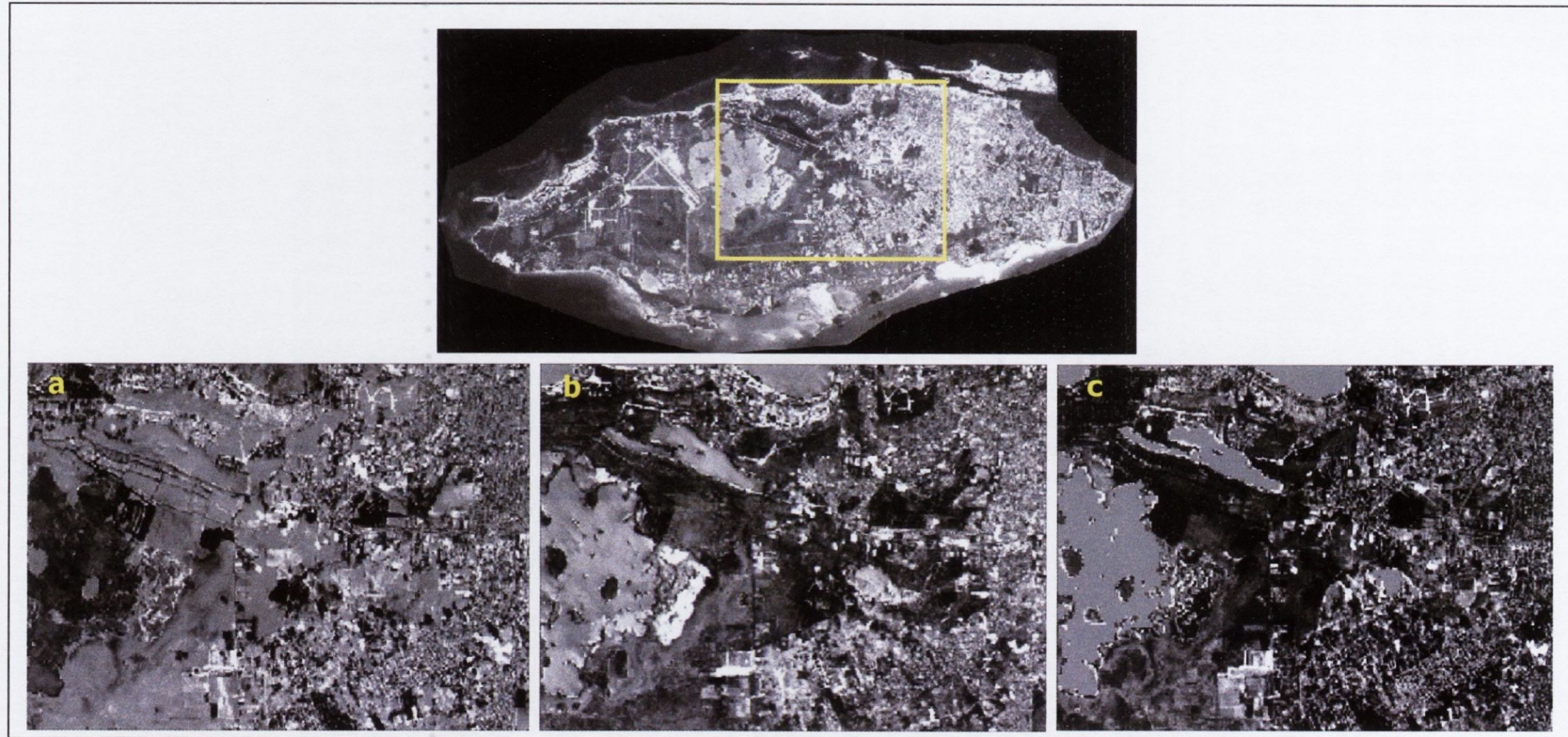


Figure 10.2. Comparison of the success of a) brightness PC4 b) greenness PC2 and c) NDVI PC4 to highlight landscape change between 1986 and 1999.

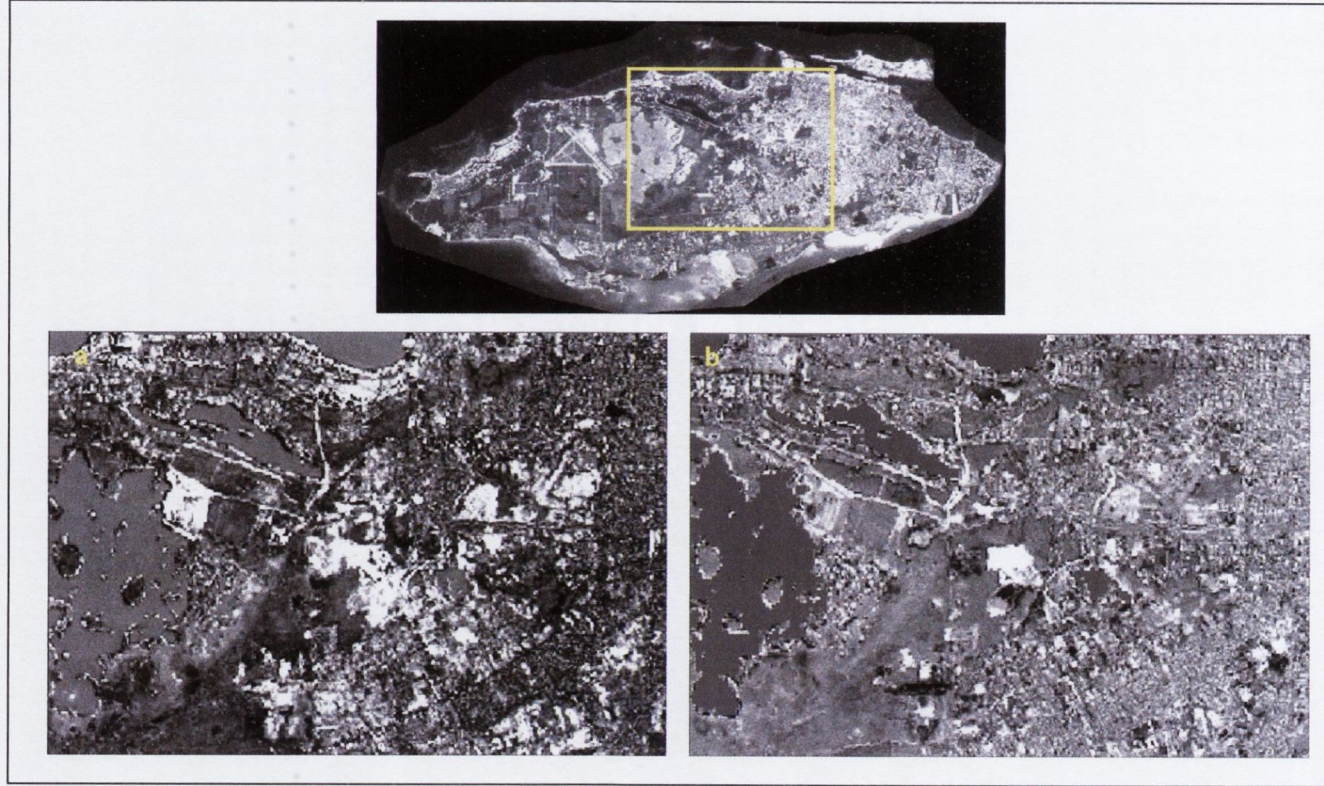


Figure 10.3. Comparison of the success of a) greenness PC3 and b) NDVI PC3 generated following multitemporal PCA to highlight landscape change between 1999 and 2002.

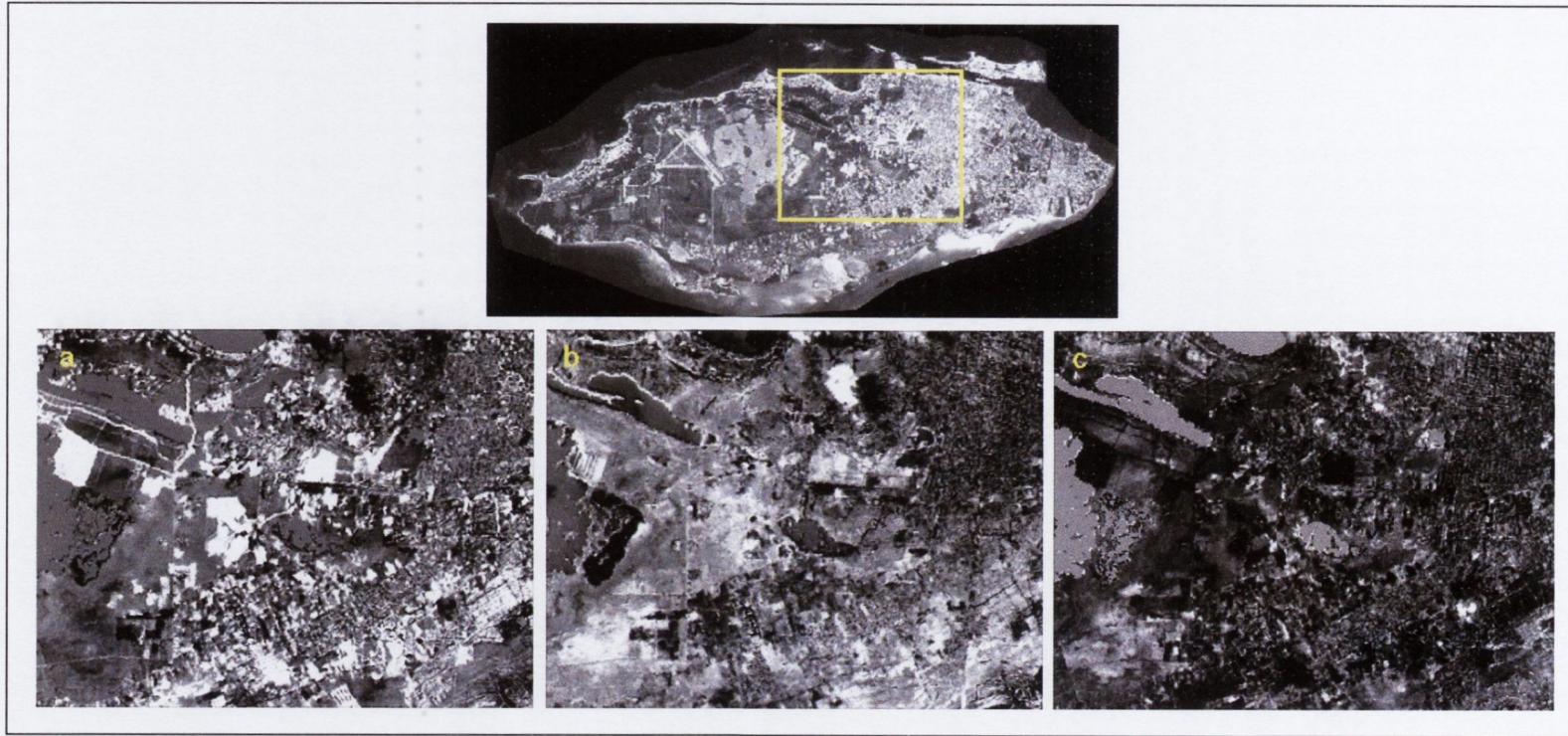


Figure 10.4. Comparison of the success of a) brightness PC3 b) greenness PC2 and c) NDVI PC4 generated following multitemporal PCA on highlight landscape change between 1985 and 1999.

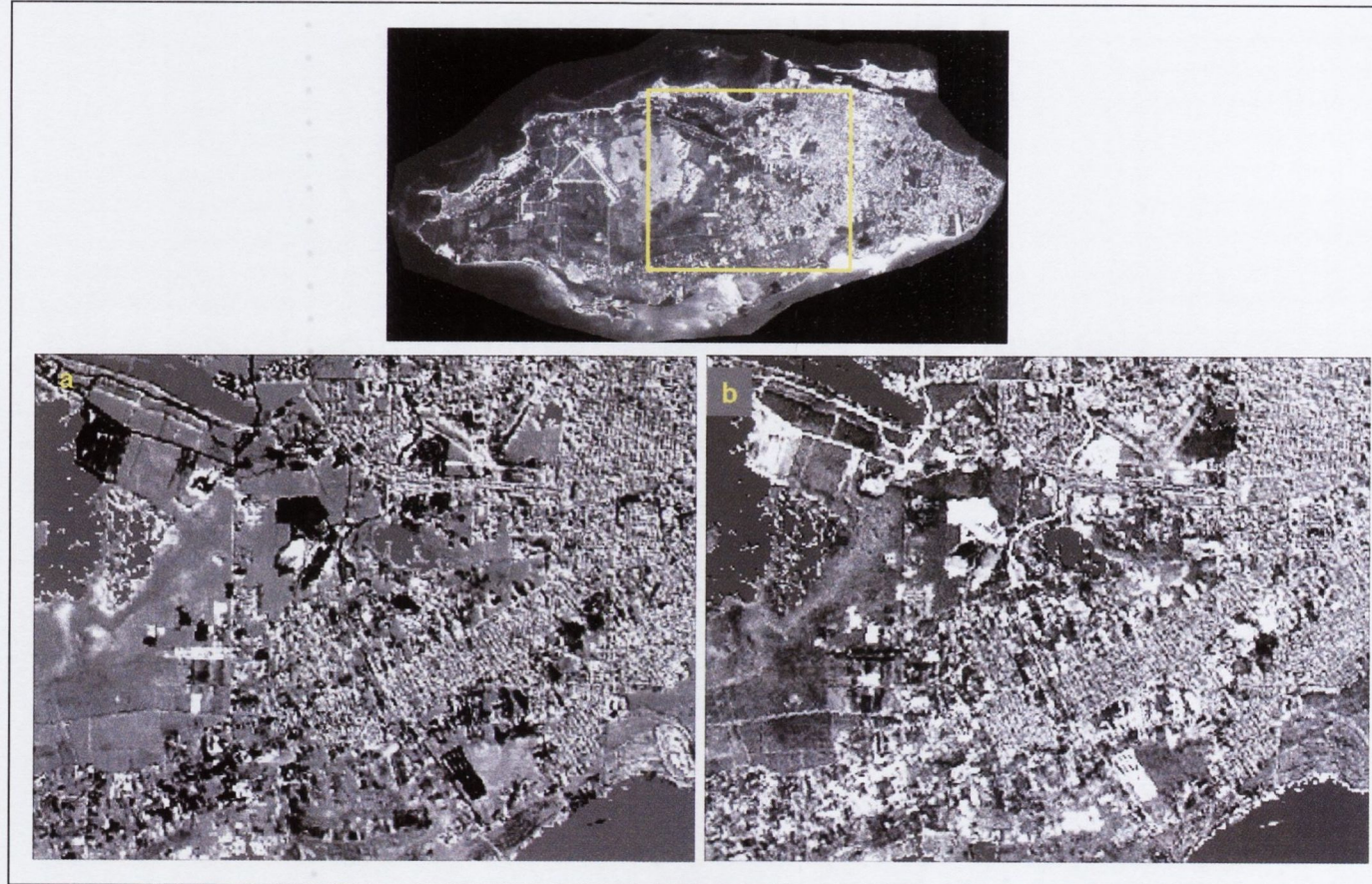


Figure 10.5. A comparison of the success of a) brightness PC2 and b) NDVI PC3 generated following multitemporal PCA on the to highlight landscape change between 1999 and 2002.

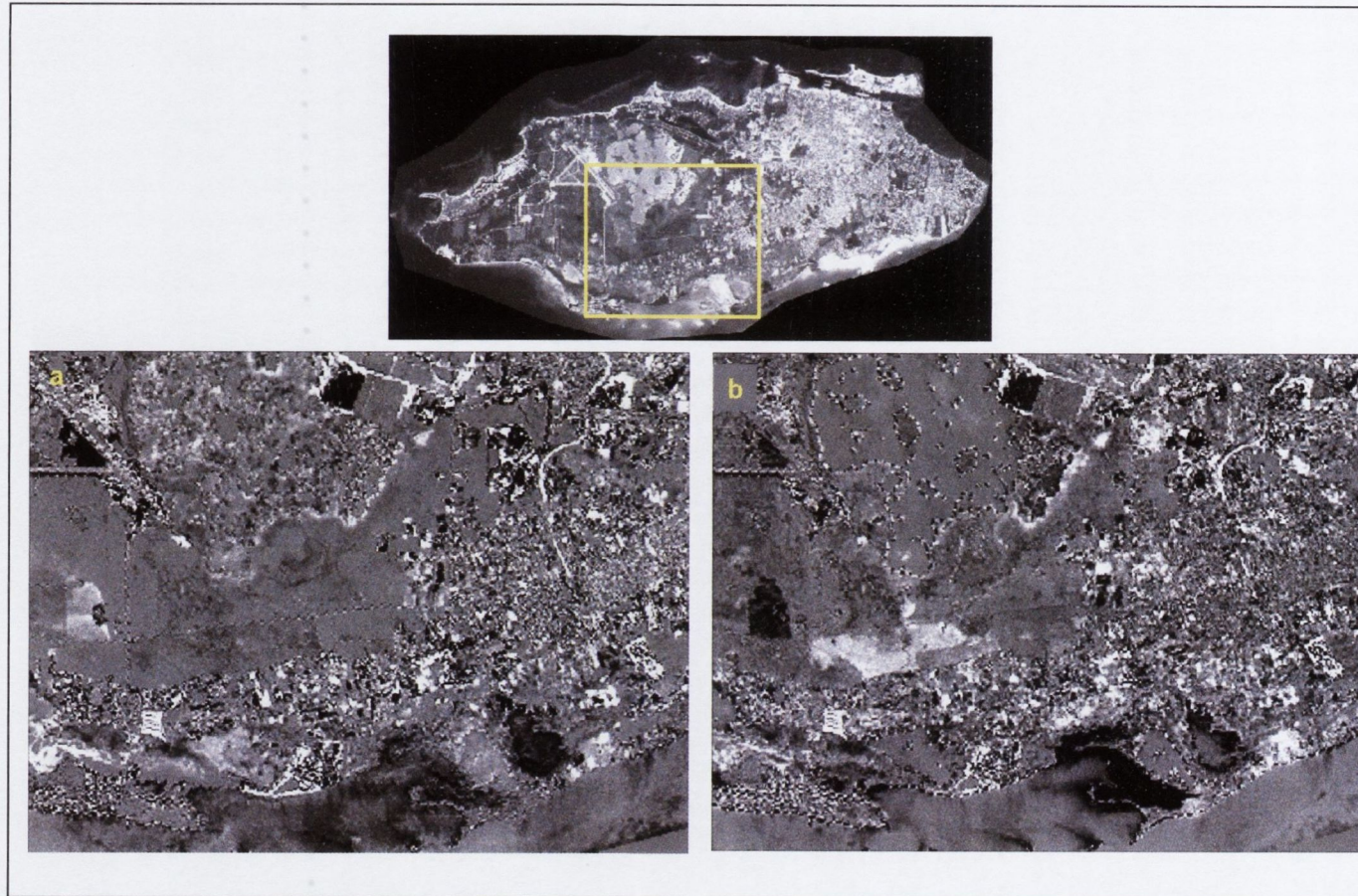


Figure 10.6. A comparison of the success of a) brightness PC4 and b) greenness PC4 generated following multitemporal PCA to highlight landscape change between 2001 and 2002.

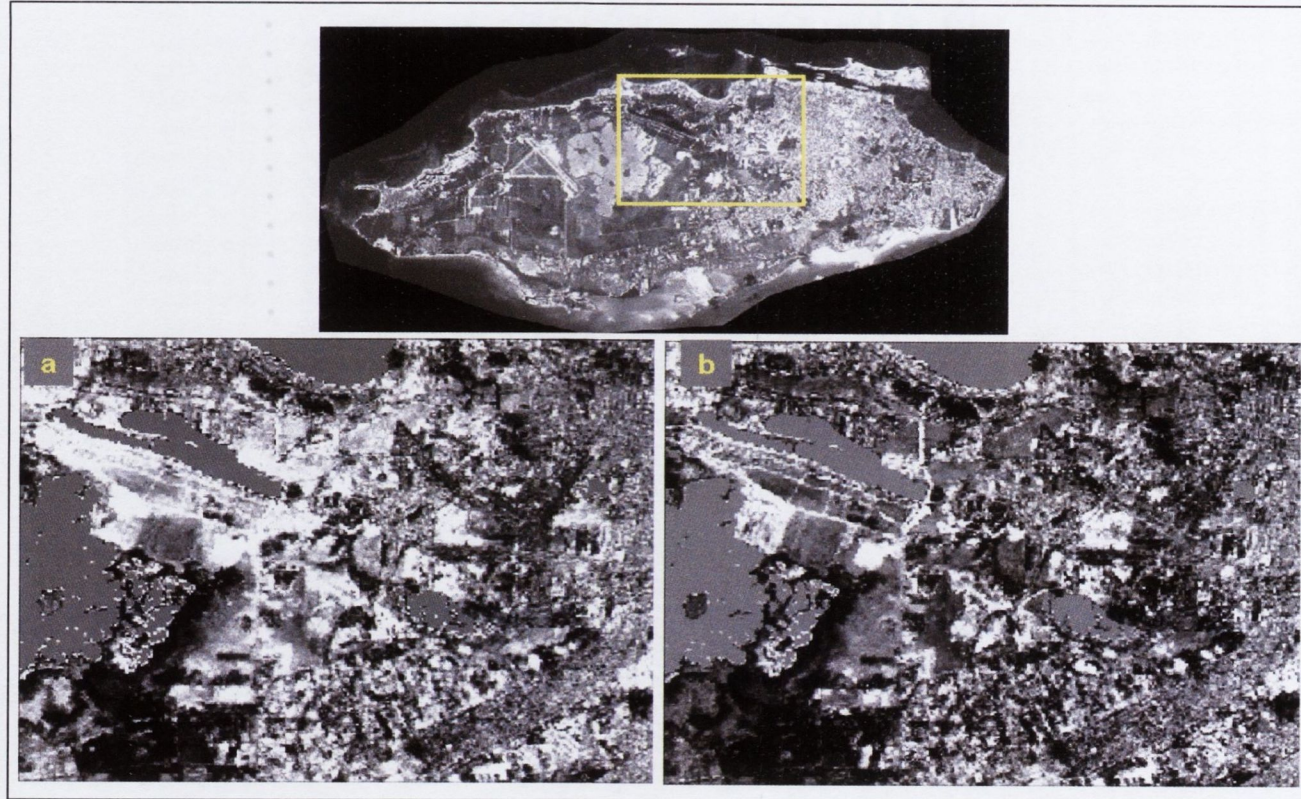


Figure 10.7. Comparison of the success of a) NDBI PC3 and b) BI PC3 generated following multitemporal PCA to highlight landscape change between 1985 and 2002.

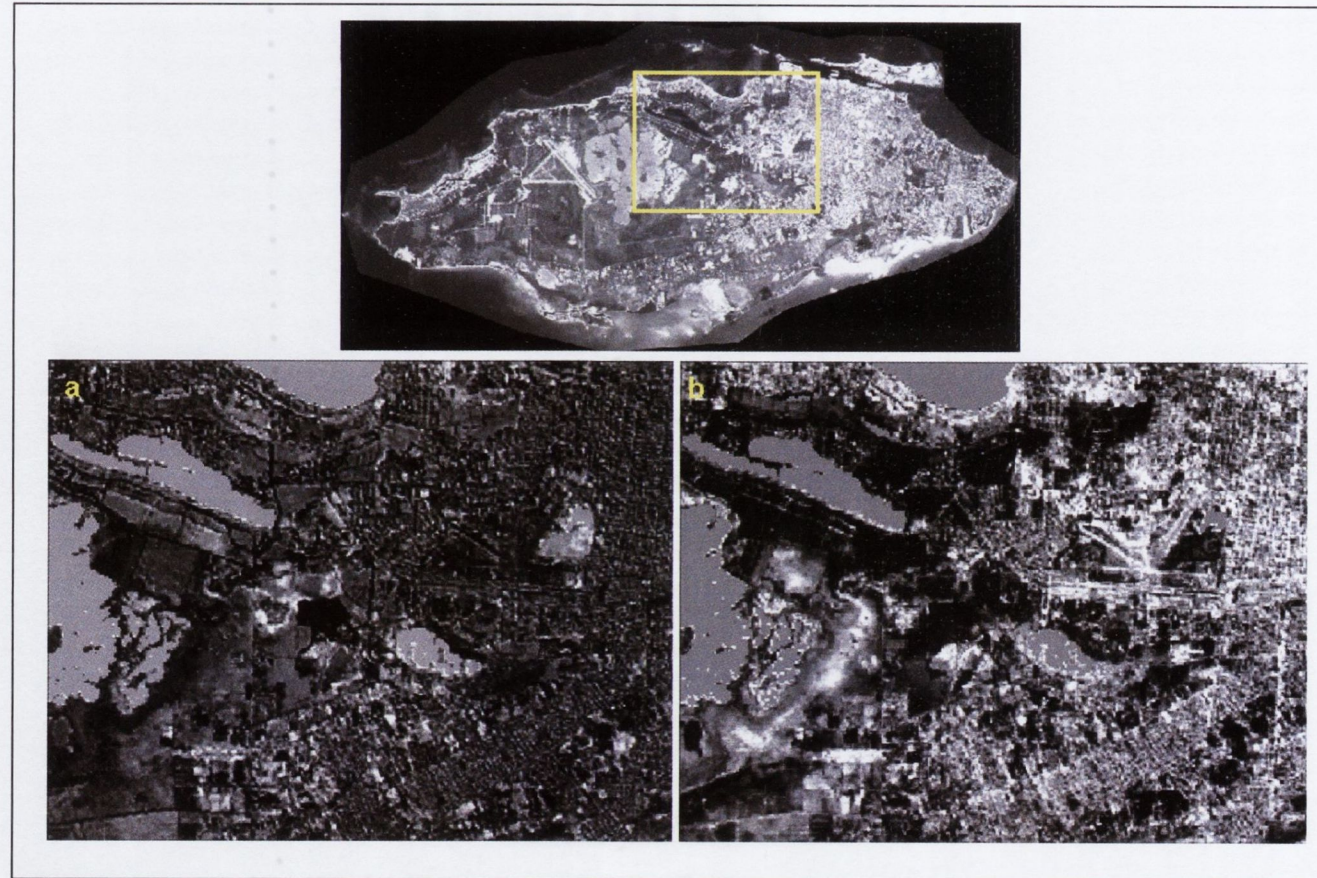


Figure 10.8. Comparison of the success of a) NDBI PC2 and b) BI PC2 generated following multitemporal PCA to highlight landscape change between 1999 and 2002.

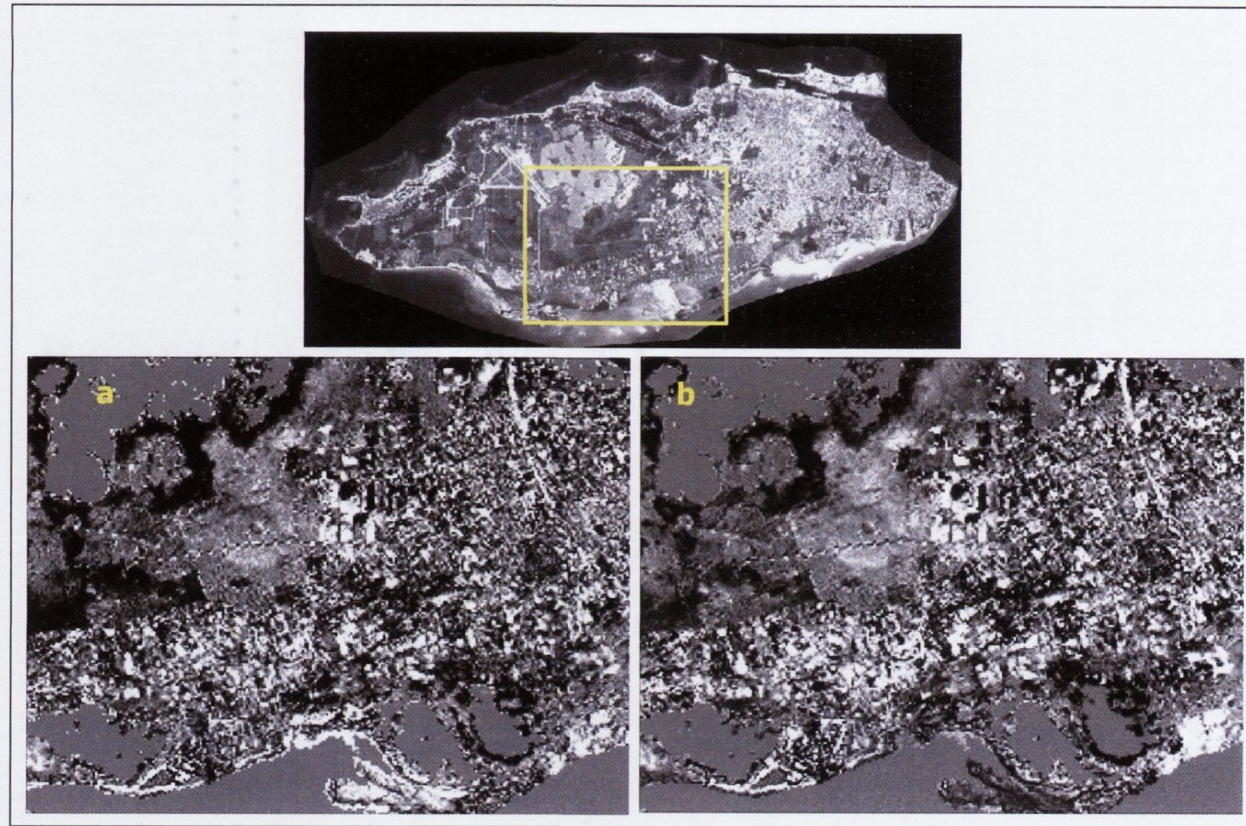


Figure 10.9. Comparison of the success of a) NDBI PC4 and b) BI PC4 generated following multitemporal to highlight landscape change between 2001 and 2002.

Table 10.1. A summary of unique information content accounted for by higher order PCs (2 though 4) generated following multitemporal PCA on the 1985-1999-2001-2002 time series.

Multitemporal PCA method	Percent variance contribution			
	PC2	PC3	PC4	Cumulative variance %
Brightness	7.1	4.3	1.8	13.2
Greenness	2.2	1.9	0.7	4.8
NDVI	14.3	6.4	2.0	22.7
NDBI	17.0	5.5	3.7	26.2
BI	10.4	5.6	4.4	20.4

Table 10.2. A summary of landscape change information highlighted within PC images derived from multitemporal PCA applied to a time series of brightness, greenness, NDVI, NDBI and BI imagery for the years 1985-1999-2001-2002.

Period of change highlighted	PC image number	Information content (%)	Time series
1985-2002	PC3	1.9	Greenness
	PC3	5.5	NDBI
	PC3	5.6	BI
1999-2002	PC2	7.1	Brightness
	PC3	6.4	NDVI
	PC2	17.0	NDBI
	PC2	10.4	BI
2001-2002	PC4	1.8	Brightness
	PC4	0.7	Greenness
	PC4	3.7	NDBI
	PC4	4.4	BI

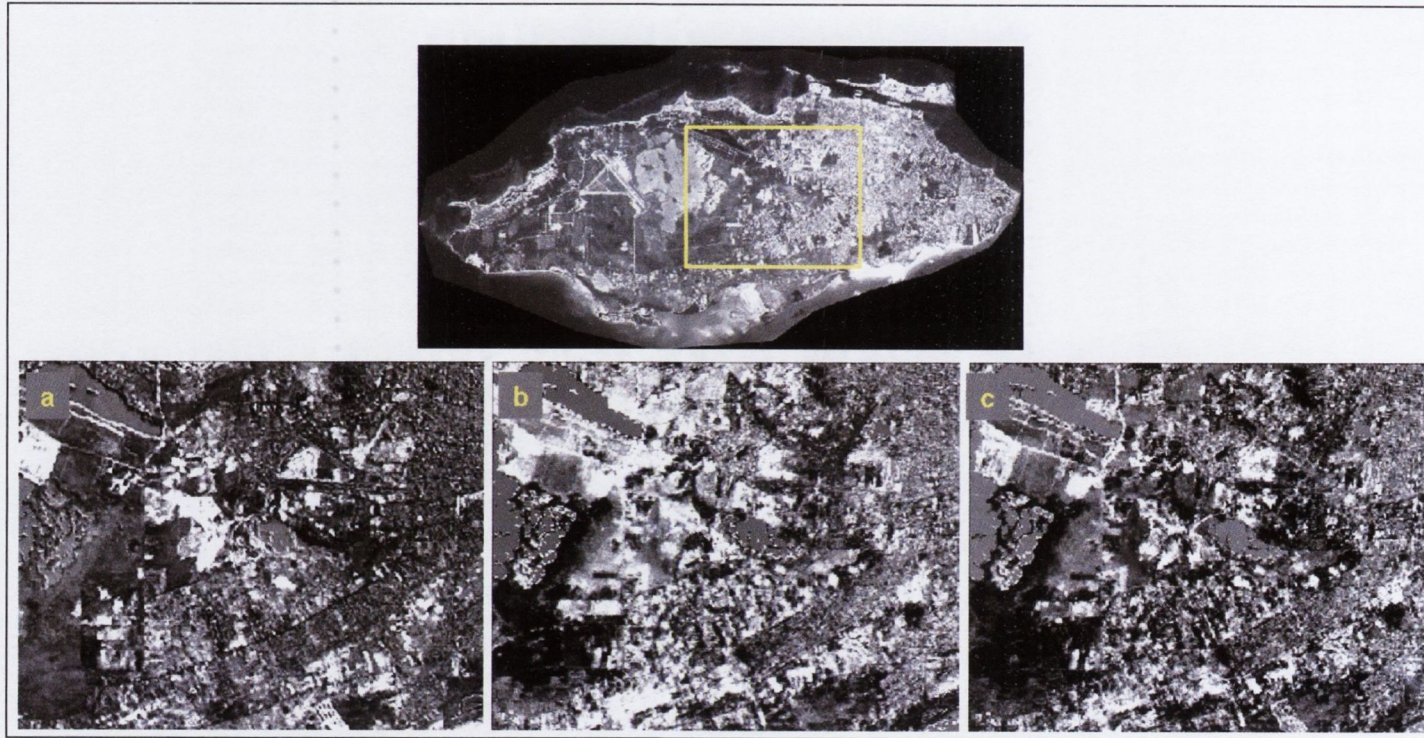


Figure 10.10. Comparison of the success of a) greenness PC3 b) NDBI PC3 and c) BI PC3 generated following multitemporal PCA to highlight landscape change between 1985 and 2002.

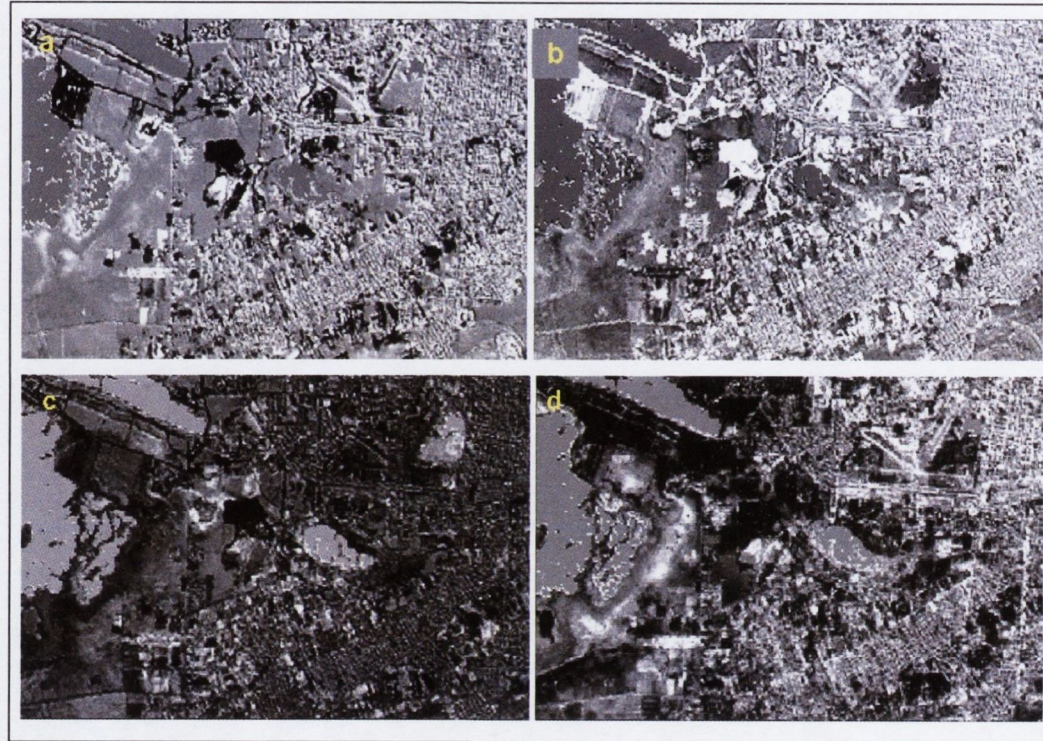


Figure 10.11. Comparison of the success of a) brightness PC2 b) NDVI PC3 c) NDBI PC2 and d) BI PC2 generated following multitemporal PCA to highlight landscape change between 1999 and 2002.

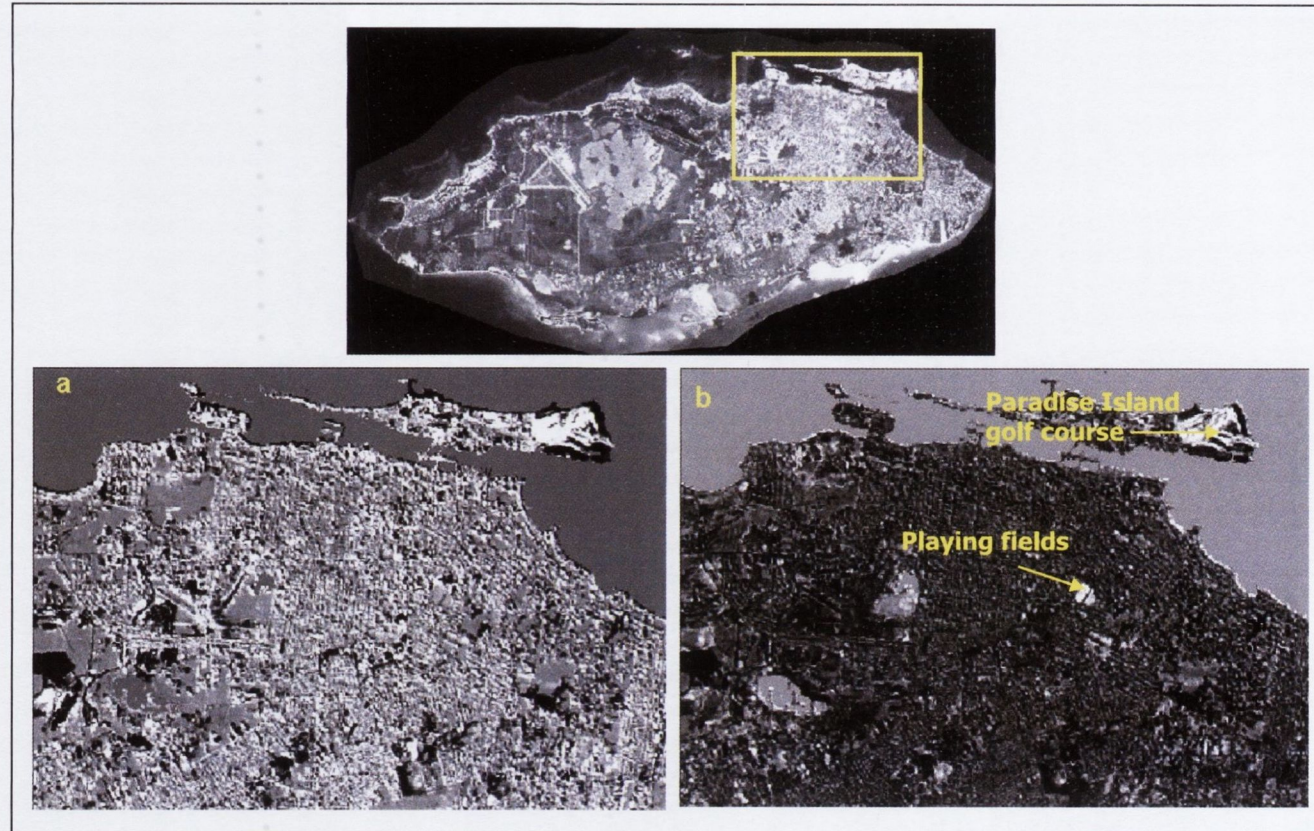


Figure 10.12. Comparison of the success of a) brightness PC2 and b) NDBI PC2 generated following multitemporal PCA to highlight landscape change between 1999 and 2002.

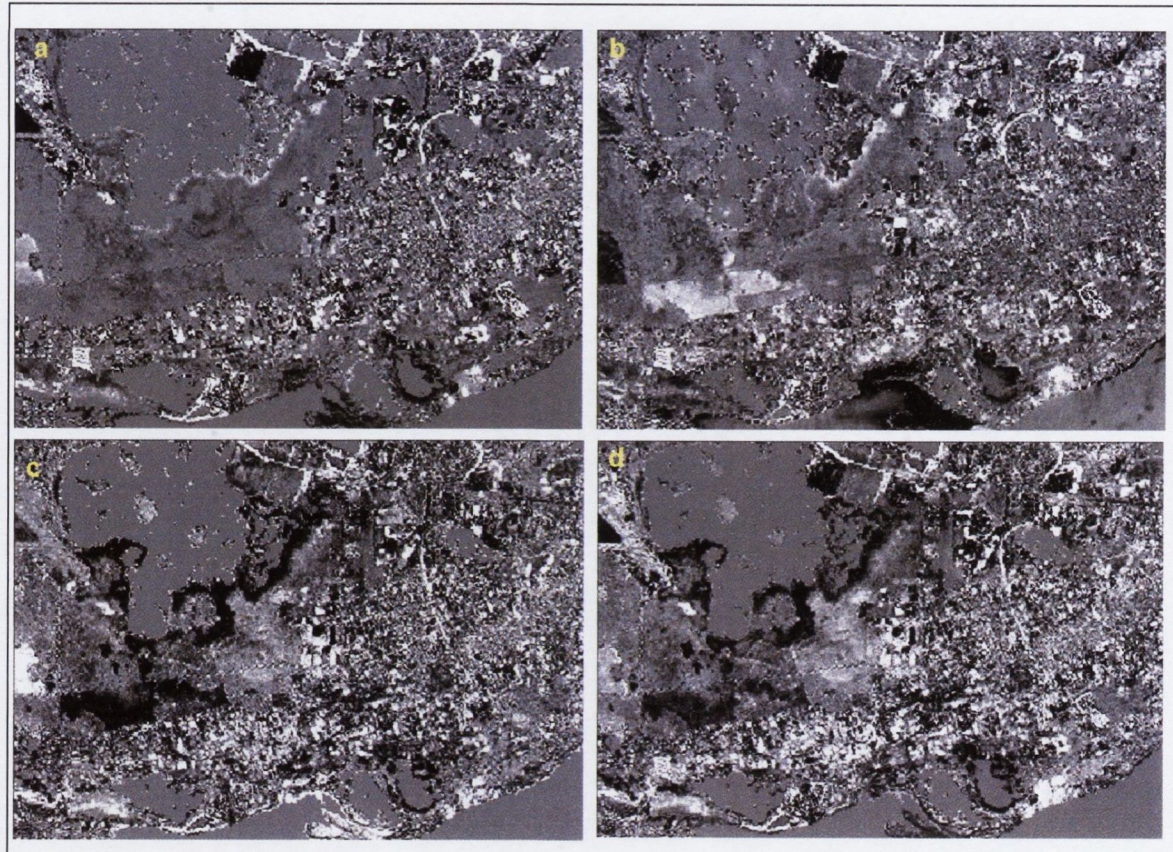


Figure 10.13. Comparison of the success of a) brightness PC4 b) greenness PC4 c) NDBI PC4 and d) BI PC4 generated following multitemporal PCA to highlight landscape change between 1999 and 2002.

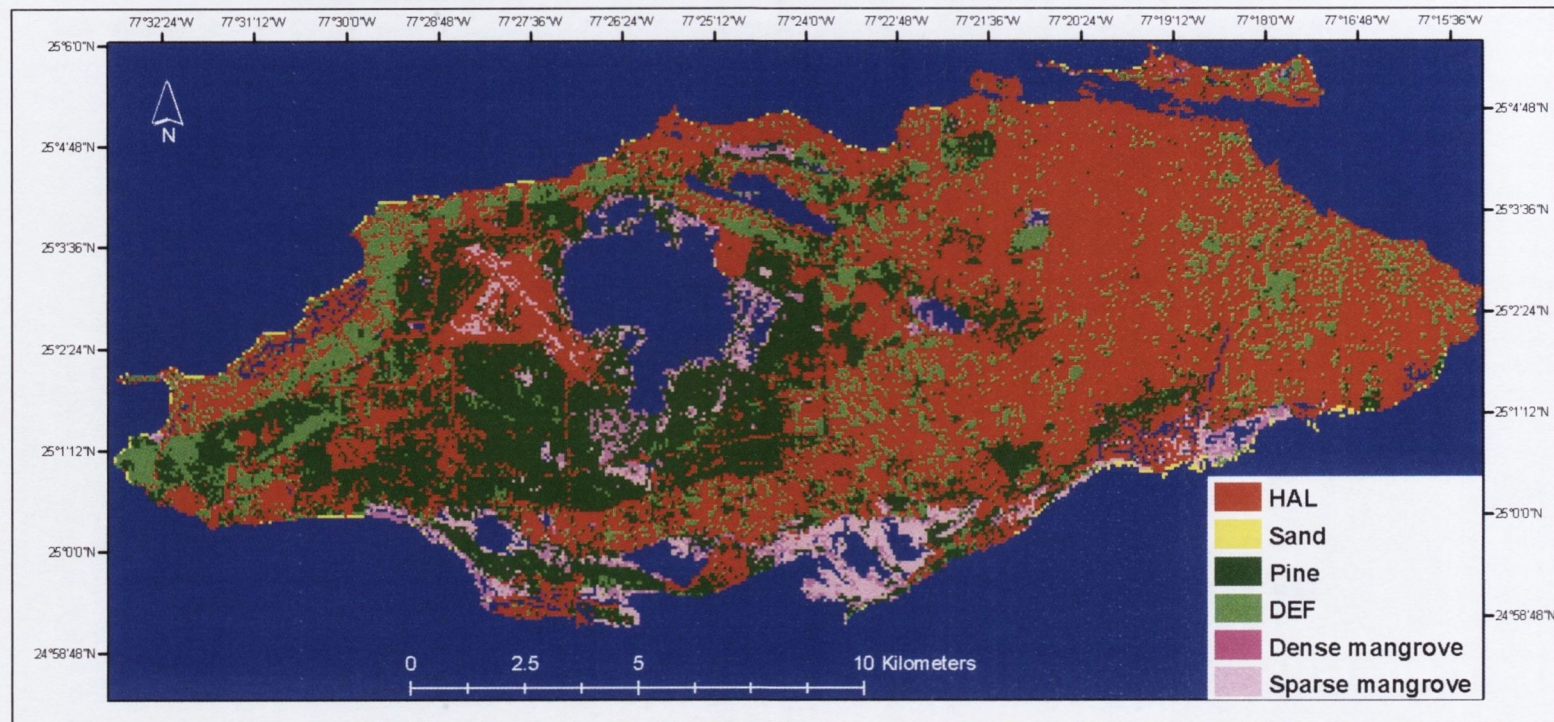


Figure 10.14. Land cover map of New Providence Island produced following unsupervised classification of the Landsat ETM+ 2001 visible and infrared wavebands.

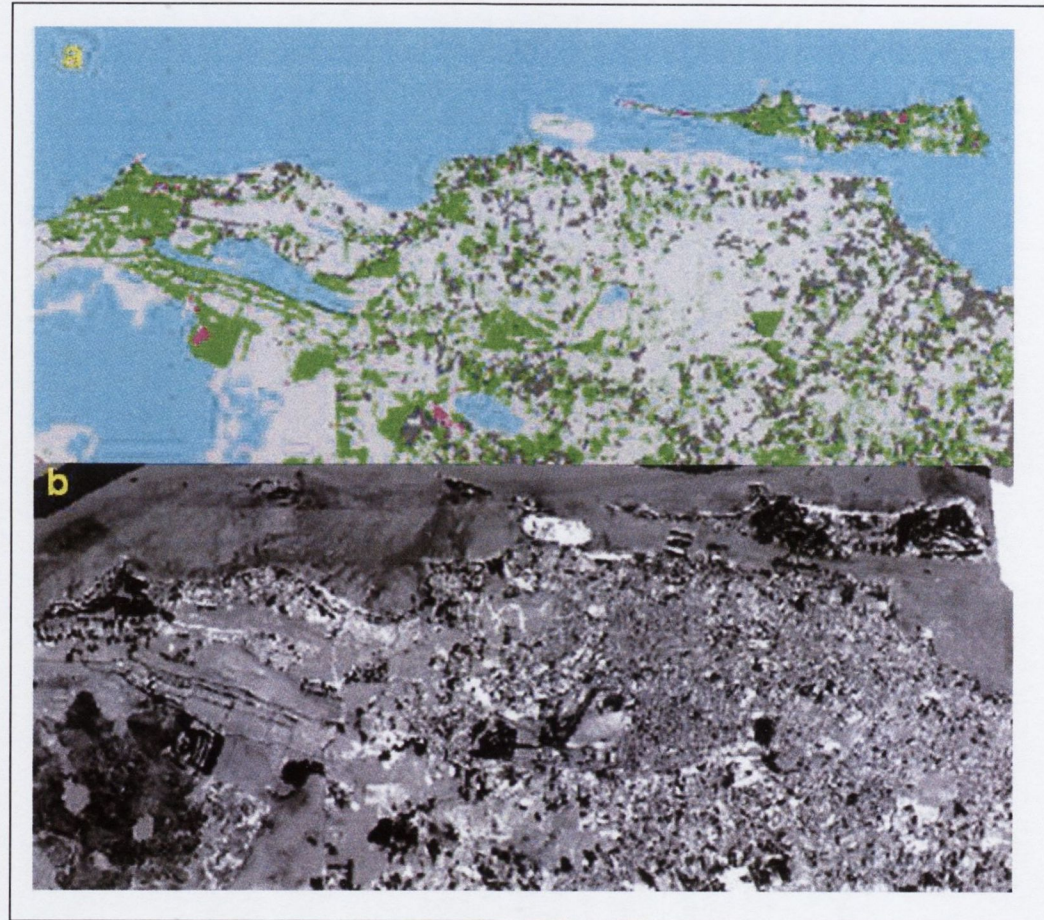


Figure 10.14. A comparison of landscape change between 1986 and 1999 illustrated by a) a land cover conversion map and b) brightness PC4 from the 1973-2002 time series.

Appendix A

Landsat and SPOT image data header files

A.1. Landsat MSS 1973

```
NDF_REVISION=2.00;
DATA_SET_TYPE=EDC_MSS;
PRODUCT_NUMBER=01400061400080014;
PIXEL_FORMAT=BYTE;
PIXEL_ORDER=NOT_INVERTED;
BITS_PER_PIXEL=8;
PIXELS_PER_LINE=3705;
LINES_PER_DATA_FILE=3305;
DATA_ORIENTATION=UPPER_LEFT/RIGHT;
NUMBER_OF_DATA_FILES=4;
DATA_FILE_INTERLEAVING=BSQ;
TAPE_SPANNING_FLAG=1/1;
START_LINE_NUMBER=1;
START_DATA_FILE=1;
LINES_PER_VOLUME=13220;
BLOCKING_FACTOR=1;
RECORD_SIZE=3705;
UPPER_LEFT_CORNER=0790747.7418W,0253116.9454N,17292896.393,276323.729;
UPPER_RIGHT_CORNER=0770348.9495W,0251139.4530N,17306180.491,487033.397;
LOWER_RIGHT_CORNER=0772336.9080W,0233116.7489N,17494135.337,475183.867;
LOWER_LEFT_CORNER=0792600.5710W,0235039.1573N,17480851.239,264474.199;
REFERENCE_POINT=SCENE_CENTER;
REFERENCE_POSITION=0781517.5743W,0243126.0508N,17393515.864,375753.805,1853.00,1653.00
;
REFERENCE_OFFSET=104.08,29.11;
ORIENTATION=-86.392587;
MAP_PROJECTION_NAME=SPACE_OBLIQUE_MERC;
USGS_PROJECTION_NUMBER=22;
USGS_PROJECTION_PARAMETERS=6378137.0000000000000000,6356752.314140000400000,1.000000
000000000,14.000000000000000,0.000000000000000,0.000000000000000,0.000000000000000,0.00
000000000000000,0.000000000000000,0.000000000000000,0.000000000000000,0.000000000000000,1
.000000000000000,0.000000000000000,0.000000000000000;
HORIZONTAL_DATUM=WGS84;
EARTH_ELLIPSOID_SEMI-MAJOR_AXIS=6378137.000;
EARTH_ELLIPSOID_SEMI-MINOR_AXIS=6356752.314;
EARTH_ELLIPSOID_ORIGIN_OFFSET=0.000,0.000,0.000;
EARTH_ELLIPSOID_ROTATION_OFFSET=0.000000,0.000000,0.000000;
PRODUCT_SIZE=FULL_SCENE;
PIXEL_SPACING=57.0000,57.0000;
PIXEL_SPACING_UNITS=METERS;
RESAMPLING=CC;
PROCESSING_DATE/TIME=2000-06-15T13:05:49;
PROCESSING_SOFTWARE=NLAPS_4_1_4e2;
NUMBER_OF_BANDS_IN_VOLUME=4;
WRS=014/043;
ACQUISITION_DATE/TIME=1973-12-15T15:09:33Z;
SATELLITE=LANDSAT_1;
SATELLITE_INSTRUMENT=MSS;
PROCESSING_LEVEL=08;
```


SUN_ELEVATION=34.91;
SUN_AZIMUTH=147.60;
BAND1_NAME=MSS_BAND_4;
BAND1_FILENAME=LM1014043007334990.I1;
BAND1_WAVELENGTHS=0.50,0.60;
BAND1_RADIOMETRIC_GAINS/BIAS=0.9725490,0.0000000;
BAND2_NAME=MSS_BAND_5;
BAND2_FILENAME=LM1014043007334990.I2;
BAND2_WAVELENGTHS=0.60,0.70;
BAND2_RADIOMETRIC_GAINS/BIAS=0.7843137,0.0000000;
BAND3_NAME=MSS_BAND_6;
BAND3_FILENAME=LM1014043007334990.I3;
BAND3_WAVELENGTHS=0.70,0.80;
BAND3_RADIOMETRIC_GAINS/BIAS=0.6901961,0.0000000;
BAND4_NAME=MSS_BAND_7;
BAND4_FILENAME=LM1014043007334990.I4;
BAND4_WAVELENGTHS=0.80,1.10;
BAND4_RADIOMETRIC_GAINS/BIAS=0.5228745,0.0000000;
END_OF_HDR;

A.2. Landsat TM January 1985

NDF_REVISION=2.00;
DATA_SET_TYPE=EDC_TM;
PRODUCT_NUMBER=01400042700310003;
PIXEL_FORMAT=BYTE;
PIXEL_ORDER=NOT_INVERTED;
BITS_PER_PIXEL=8;
PIXELS_PER_LINE=6934;
LINES_PER_DATA_FILE=6299;
DATA_ORIENTATION=UPPER_LEFT/RIGHT;
NUMBER_OF_DATA_FILES=7;
DATA_FILE_INTERLEAVING=BSQ;
TAPE_SPANNING_FLAG=1/1;
START_LINE_NUMBER=1;
START_DATA_FILE=1;
LINES_PER_VOLUME=44093;
BLOCKING_FACTOR=1;
RECORD_SIZE=6934;
UPPER_LEFT_CORNER=0771657.0505W,0240250.4493N,17440394.595,257835.634;
UPPER_RIGHT_CORNER=0752156.9932W,0234608.3027N,17452934.149,455027.837;
LOWER_RIGHT_CORNER=0753854.8450W,0221010.8423N,17632065.333,443636.792;
LOWER_LEFT_CORNER=0773235.5789W,0222641.2167N,17619525.779,246444.590;
REFERENCE_POINT=SCENE_CENTER;
REFERENCE_POSITION=0762735.4982W,0230638.3572N,17536229.964,350736.217,3467.50,3150.00
;
REFERENCE_OFFSET=-146.15,-0.72;
ORIENTATION=-86.361431;
MAP_PROJECTION_NAME=SPACE_OBLIQUE_MERC;
USGS_PROJECTION_NUMBER=22;
USGS_PROJECTION_PARAMETERS=6378137.0000000000000000,6356752.314140000400000,5.000000
000000000,12.000000000000000,0.000000000000000,0.000000000000000,0.000000000000000,0.00
000000000000000,0.000000000000000,0.000000000000000,0.000000000000000,0.000000000000000,1
.000000000000000,0.000000000000000,0.000000000000000;
HORIZONTAL_DATUM=WGS84;
EARTH_ELLIPSOID_SEMI-MAJOR_AXIS=6378137.000;
EARTH_ELLIPSOID_SEMI-MINOR_AXIS=6356752.314;
EARTH_ELLIPSOID_ORIGIN_OFFSET=0.000,0.000,0.000;
EARTH_ELLIPSOID_ROTATION_OFFSET=0.000000,0.000000,0.000000;
PRODUCT_SIZE=FULL_SCENE;
PIXEL_SPACING=28.5000,28.5000;
PIXEL_SPACING_UNITS=METERS;
RESAMPLING=CC;
PROCESSING_DATE/TIME=2000-05-25T16:05:42;
PROCESSING_SOFTWARE=NLAPS_4_1_3e;
NUMBER_OF_BANDS_IN_VOLUME=7;
WRS=012/044;
ACQUISITION_DATE/TIME=1985-01-29T15:02:41Z;
SATELLITE=LANDSAT_5;
SATELLITE_INSTRUMENT=TM;
PROCESSING_LEVEL=08;
SUN_ELEVATION=37.75;
SUN_AZIMUTH=139.01;
BAND1_NAME=TM_BAND_1;
BAND1_FILENAME=LT5012044008502910.I1;
BAND1_WAVELENGTHS=0.45,0.52;

BAND1_RADIOMETRIC_GAINS/BIAS=0.6024314,-1.5200000;
BAND2_NAME=TM_BAND_2;
BAND2_FILENAME=LT5012044008502910.I2;
BAND2_WAVELENGTHS=0.52,0.60;
BAND2_RADIOMETRIC_GAINS/BIAS=1.1750981,-2.8399999;
BAND3_NAME=TM_BAND_3;
BAND3_FILENAME=LT5012044008502910.I3;
BAND3_WAVELENGTHS=0.63,0.69;
BAND3_RADIOMETRIC_GAINS/BIAS=0.8057647,-1.1700000;
BAND4_NAME=TM_BAND_4;
BAND4_FILENAME=LT5012044008502910.I4;
BAND4_WAVELENGTHS=0.76,0.90;
BAND4_RADIOMETRIC_GAINS/BIAS=0.8145490,-1.5100000;
BAND5_NAME=TM_BAND_5;
BAND5_FILENAME=LT5012044008502910.I5;
BAND5_WAVELENGTHS=1.55,1.75;
BAND5_RADIOMETRIC_GAINS/BIAS=0.1080784,-0.3700000;
BAND6_NAME=TM_BAND_6;
BAND6_FILENAME=LT5012044008502910.I6;
BAND6_WAVELENGTHS=10.40,12.50;
BAND6_RADIOMETRIC_GAINS/BIAS=0.0551584,1.2377996;
BAND7_NAME=TM_BAND_7;
BAND7_FILENAME=LT5012044008502910.I7;
BAND7_WAVELENGTHS=2.08,2.35;
BAND7_RADIOMETRIC_GAINS/BIAS=0.0569804,-0.1500000;
END_OF_HDR;

A.3. SPOT HRV 1986 and HRVIR 1999

Sequence
number
Item Type Description
1 3 SCENE 1 630-300 86-04-26 15:56:31 2 X Level 2A SAT 0
2 1 SCENE 4 629-300 99-11-15 16:07:24 2 I Level 2A SAT 0
3 2 SCENE 4 629-300 99-11-15 16:07:24 2 M Level 2A SAT 0
Volume : CDRom 2050054302
Order Number : 0147565
Date : 2006-01-17 16:04:54
Number of items on CDRom: 3

Scene Extract Parameters
Scene ID 1 630-300 86-04-26 15:56:31 2 X
K-J identification 630-300
Date 1986-04-26 15:56:31
Instrument HRV 2
Shift Along Track 0 0
Preprocessing level 2A
Spectral mode XS
Number of spectral bands 3
Spectral band indicator XS1 XS2 XS3
Gain number 5 6 5
Absolute calibration gains
(W/m2/sr/µm)
0.93885 1.05623 1.10638
Orientation angle 9.7 degree
Incidence angle L2.3 degree
Sun angles (degree) Azimut: 122.1 Elevation: 69.7
Number of lines 3470
Number of pixels per line 3673
Scene Center Location
Latitude N024° 59' 50"
Longitude W077° 16' 39"
Pixels number 1834
Line number 1734
Corners Location
Corner Latitude Longitude Pixel n° Line n°
1 N025° 18'24" W077° 30'00" 743 1
2 N025° 12'56" W076° 55'00" 3673 554
3 N024° 46'40" W077° 38'10" 1 2918
4 N024° 41'14" W077° 03'19" 2931 3471
Files Parameters
Record Length Number of Records Offset
METADATA.DIM 1456618 1 0
STYLE.XSL 33722 1 0
IMAGERY.TIF 38237036 1 0
PREVIEW.JPG 315510 1 0
ICON.JPG 9208 1 0
Work Order : 0147565-3 (156999101)
Volume : CDRom 2050054302
Scene ID : 1 630-300 86-04-26 15:56:31 2 X
Product Code : SCSC1C20A
Date : 2006-01-17 16:04:54

Work Order : 0147565-3 (156999101)
Volume : CDR0M 2050054302
Scene ID : 1 630-300 86-04-26 15:56:31 2 X
Product Code : SCSC1C20A
Date : 2006-01-17 16:04:54

Scene Extract Parameters

Scene ID 4 629-300 99-11-15 16:07:24 2 I
K-J identification 629-300
Date 1999-11-15 16:07:24
Instrument HRVIR 2
Shift Along Track 0 0
Preprocessing level 2A
Spectral mode XI
Number of spectral bands 4
Spectral band indicator XS1 XS2 XS3 XS4
Gain number 6 6 6 6
Absolute calibration gains
(W/m²/sr/μm)
3.48665 4.39204 4.71456 28.55324
Orientation angle 10.8 degree
Incidence angle L21.3 degree
Sun angles (degree) Azimut: 163.8 Elevation: 45.3
Number of lines 3606
Number of pixels per line 4138
Scene Center Location
Latitude N024° 59' 56"
Longitude W077° 34' 57"
Pixels number 2044
Line number 1798
Corners Location
Corner Latitude Longitude Pixel n° Line n°
1 N025° 19'07" W077° 50'06" 806 1
2 N025° 12'09" W077° 10'17" 4138 706
3 N024° 47'31" W077° 58'56" 1 2903
4 N024° 40'36" W077° 19'17" 3332 3606

Files Parameters

Record Length Number of Records Offset
METADATA.DIM 1951753 1 0
STYLE.XSL 33722 1 0
IMAGERY.TIF 59687896 1 0
PREVIEW.JPG 283420 1 0
ICON.JPG 9452 1 0
Work Order : 0147565-1 (156997101)
Volume : CDR0M 2050054302
Scene ID : 4 629-300 99-11-15 16:07:24 2 I
Product Code : SCSG1C20A
Date : 2006-01-17 16:04:54

Work Order : 0147565-1 (156997101)
Volume : CDR0M 2050054302
Scene ID : 4 629-300 99-11-15 16:07:24 2 I
Product Code : SCSG1C20A
Date : 2006-01-17 16:04:54

Scene Extract Parameters

Scene ID 4 629-300 99-11-15 16:07:24 2 M

K-J identification 629-300

Date 1999-11-15 16:07:24

Instrument HRVIR 2

Shift Along Track 0 0

Preprocessing level 2A

Spectral mode M

Number of spectral bands 1

Spectral band indicator PAN

Gain number 6

Absolute calibration gains

(W/m²/sr/μm)

4.39204

Orientation angle 10.8 degree

Incidence angle L21.3 degree

Sun angles (degree) Azimut: 163.8 Elevation: 45.3

Number of lines 7213

Number of pixels per line 8276

Scene Center Location

Latitude N024° 59' 56"

Longitude W077° 34' 57"

Pixels number 4088

Line number 3597

Corners Location

Corner Latitude Longitude Pixel n° Line n°

1 N025° 19'07" W077° 50'06" 1613 1

2 N025° 12'09" W077° 10'17" 8276 1412

3 N024° 47'31" W077° 58'57" 1 5805

4 N024° 40'36" W077° 19'17" 6665 7213

Files Parameters

Record Length Number of Records Offset

METADATA.DIM 975738 1 0

STYLE.XSL 33722 1 0

IMAGERY.TIF 59695654 1 0

PREVIEW.JPG 210747 1 0

ICON.JPG 5904 1 0

Work Order : 0147565-2 (156998101)

Volume : CDR0M 2050054302

Scene ID : 4 629-300 99-11-15 16:07:24 2 M

Product Code : SCS21C20A

Date : 2006-01-17 16:04:54

Work Order : 0147565-2 (156998101)

Volume : CDR0M 2050054302

Scene ID : 4 629-300 99-11-15 16:07:24 2 M

Product Code : SCS21C20A

Date : 2006-01-17 16:04:54

A.4. Landsat ETM+ 2001

GROUP = METADATA_FILE
PRODUCT_CREATION_TIME = 2004-02-12T15:32:50Z
PRODUCT_FILE_SIZE = 685.4
STATION_ID = "EDC"
GROUND_STATION = "EDC"
GROUP = ORTHO_PRODUCT_METADATA
SPACECRAFT_ID = "Landsat7"
SENSOR_ID = "ETM+"
ACQUISITION_DATE = 2001-05-16
WRS_PATH = 013
WRS_ROW = 043
SCENE_CENTER_LAT = +24.5604115
SCENE_CENTER_LON = -77.7158669
SCENE_UL_CORNER_LAT = +25.5004436
SCENE_UL_CORNER_LON = -78.4173552
SCENE_UR_CORNER_LAT = +25.2395710
SCENE_UR_CORNER_LON = -76.6193274
SCENE_LL_CORNER_LAT = +23.8748321
SCENE_LL_CORNER_LON = -78.8001560
SCENE_LR_CORNER_LAT = +23.6156368
SCENE_LR_CORNER_LON = -77.0251917
SCENE_UL_CORNER_MAPX = 156436.500
SCENE_UL_CORNER_MAPY = 2824777.500
SCENE_UR_CORNER_MAPX = 336898.500
SCENE_UR_CORNER_MAPY = 2792458.500
SCENE_LL_CORNER_MAPX = 112917.000
SCENE_LL_CORNER_MAPY = 2645569.500
SCENE_LR_CORNER_MAPX = 293379.000
SCENE_LR_CORNER_MAPY = 2613136.500
BAND1_FILE_NAME = "p013r043_7t20010516_z18_nn10.tif"
BAND2_FILE_NAME = "p013r043_7t20010516_z18_nn20.tif"
BAND3_FILE_NAME = "p013r043_7t20010516_z18_nn30.tif"
BAND4_FILE_NAME = "p013r043_7t20010516_z18_nn40.tif"
BAND5_FILE_NAME = "p013r043_7t20010516_z18_nn50.tif"
BAND61_FILE_NAME = "p013r043_7k20010516_z18_nn61.tif"
BAND62_FILE_NAME = "p013r043_7k20010516_z18_nn62.tif"
BAND7_FILE_NAME = "p013r043_7t20010516_z18_nn70.tif"
BAND8_FILE_NAME = "p013r043_7p20010516_z18_nn80.tif"
GROUP = PROJECTION_PARAMETERS
REFERENCE_DATUM = "WGS84"
REFERENCE_ELLIPSOID = "WGS84"
GRID_CELL_ORIGIN = "Center"
UL_GRID_LINE_NUMBER = 1
UL_GRID_SAMPLE_NUMBER = 1
GRID_INCREMENT_UNIT = "Meters"
GRID_CELL_SIZE_PAN = 14.250
GRID_CELL_SIZE_THM = 57.000
GRID_CELL_SIZE_REF = 28.500
FALSE_NORTHING = 0
ORIENTATION = "NUP"
RESAMPLING_OPTION = "NN"
MAP_PROJECTION = "UTM"
END_GROUP = PROJECTION_PARAMETERS
GROUP = UTM_PARAMETERS


```

        ZONE_NUMBER = +18
    END_GROUP = UTM_PARAMETERS
    SUN_AZIMUTH = 98.1422258
    SUN_ELEVATION = 66.3853316
    QA_PERCENT_MISSING_DATA = 0
    CLOUD_COVER = 0
    PRODUCT_SAMPLES_PAN = 17486
    PRODUCT_LINES_PAN = 15644
    PRODUCT_SAMPLES_REF = 8743
    PRODUCT_LINES_REF = 7822
    PRODUCT_SAMPLES_THM = 4372
    PRODUCT_LINES_THM = 3911
    OUTPUT_FORMAT = "GEOTIFF"
END_GROUP = ORTHO_PRODUCT_METADATA
GROUP = L1G_PRODUCT_METADATA
    BAND_COMBINATION = "123456678"
    CPF_FILE_NAME = "L7CPF20010401_20010630_06"
    GROUP = MIN_MAX_RADIANCE
        LMAX_BAND1 = 191.600
        LMIN_BAND1 = -6.200
        LMAX_BAND2 = 196.500
        LMIN_BAND2 = -6.400
        LMAX_BAND3 = 152.900
        LMIN_BAND3 = -5.000
        LMAX_BAND4 = 241.100
        LMIN_BAND4 = -5.100
        LMAX_BAND5 = 31.060
        LMIN_BAND5 = -1.000
        LMAX_BAND61 = 17.040
        LMIN_BAND61 = 0.000
        LMAX_BAND62 = 12.650
        LMIN_BAND62 = 3.200
        LMAX_BAND7 = 10.800
        LMIN_BAND7 = -0.350
        LMAX_BAND8 = 243.100
        LMIN_BAND8 = -4.700
    END_GROUP = MIN_MAX_RADIANCE
    GROUP = MIN_MAX_PIXEL_VALUE
        QCALMAX_BAND1 = 255.0
        QCALMIN_BAND1 = 1.0
        QCALMAX_BAND2 = 255.0
        QCALMIN_BAND2 = 1.0
        QCALMAX_BAND3 = 255.0
        QCALMIN_BAND3 = 1.0
        QCALMAX_BAND4 = 255.0
        QCALMIN_BAND4 = 1.0
        QCALMAX_BAND5 = 255.0
        QCALMIN_BAND5 = 1.0
        QCALMAX_BAND61 = 255.0
        QCALMIN_BAND61 = 1.0
        QCALMAX_BAND62 = 255.0
        QCALMIN_BAND62 = 1.0
        QCALMAX_BAND7 = 255.0
        QCALMIN_BAND7 = 1.0
        QCALMAX_BAND8 = 255.0
        QCALMIN_BAND8 = 1.0

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END_GROUP = MIN_MAX_PIXEL_VALUE
GROUP = PRODUCT_PARAMETERS
CORRECTION_METHOD_GAIN_BAND1 = "CPF"
CORRECTION_METHOD_GAIN_BAND2 = "CPF"
CORRECTION_METHOD_GAIN_BAND3 = "CPF"
CORRECTION_METHOD_GAIN_BAND4 = "CPF"
CORRECTION_METHOD_GAIN_BAND5 = "CPF"
CORRECTION_METHOD_GAIN_BAND61 = "CPF"
CORRECTION_METHOD_GAIN_BAND62 = "CPF"
CORRECTION_METHOD_GAIN_BAND7 = "CPF"
CORRECTION_METHOD_GAIN_BAND8 = "CPF"
CORRECTION_METHOD_BIAS = "IC"
BAND1_GAIN = "H"
BAND2_GAIN = "H"
BAND3_GAIN = "H"
BAND4_GAIN = "L"
BAND5_GAIN = "H"
BAND6_GAIN1 = "L"
BAND6_GAIN2 = "H"
BAND7_GAIN = "H"
BAND8_GAIN = "L"
BAND1_GAIN_CHANGE = "0"
BAND2_GAIN_CHANGE = "0"
BAND3_GAIN_CHANGE = "0"
BAND4_GAIN_CHANGE = "0"
BAND5_GAIN_CHANGE = "0"
BAND6_GAIN_CHANGE1 = "0"
BAND6_GAIN_CHANGE2 = "0"
BAND7_GAIN_CHANGE = "0"
BAND8_GAIN_CHANGE = "0"
BAND1_SL_GAIN_CHANGE = "0"
BAND2_SL_GAIN_CHANGE = "0"
BAND3_SL_GAIN_CHANGE = "0"
BAND4_SL_GAIN_CHANGE = "0"
BAND5_SL_GAIN_CHANGE = "0"
BAND6_SL_GAIN_CHANGE1 = "0"
BAND6_SL_GAIN_CHANGE2 = "0"
BAND7_SL_GAIN_CHANGE = "0"
BAND8_SL_GAIN_CHANGE = "0"
END_GROUP = PRODUCT_PARAMETERS
GROUP = CORRECTIONS_APPLIED
STRIPING_BAND1 = "NONE"
STRIPING_BAND2 = "NONE"
STRIPING_BAND3 = "NONE"
STRIPING_BAND4 = "NONE"
STRIPING_BAND5 = "NONE"
STRIPING_BAND61 = "NONE"
STRIPING_BAND62 = "NONE"
STRIPING_BAND7 = "NONE"
STRIPING_BAND8 = "NONE"
BANDING = "N"
COHERENT_NOISE = "N"
MEMORY_EFFECT = "N"
SCAN_CORRELATED_SHIFT = "N"
INOPERABLE_DETECTORS = "N"
DROPPED_LINES = N

```



```
        END_GROUP = CORRECTIONS_APPLIED  
    END_GROUP = L1G_PRODUCT_METADATA  
END_GROUP = METADATA_FILE
```


A.5. Landsat ETM+ 2002

GROUP = METADATA_FILE
PRODUCT_CREATION_TIME = 2004-02-12T15:32:55Z
PRODUCT_FILE_SIZE = 695.1
STATION_ID = "EDC"
GROUND_STATION = "EDC"
GROUP = ORTHO_PRODUCT_METADATA
SPACECRAFT_ID = "Landsat7"
SENSOR_ID = "ETM+ "
ACQUISITION_DATE = 2002-03-16
WRS_PATH = 013
WRS_ROW = 043
SCENE_CENTER_LAT = +24.5694237
SCENE_CENTER_LON = -77.6938424
SCENE_UL_CORNER_LAT = +25.5112206
SCENE_UL_CORNER_LON = -78.3961299
SCENE_UR_CORNER_LAT = +25.2490886
SCENE_UR_CORNER_LON = -76.5959702
SCENE_LL_CORNER_LAT = +23.8827976
SCENE_LL_CORNER_LON = -78.7794236
SCENE_LR_CORNER_LAT = +23.6233949
SCENE_LR_CORNER_LON = -77.0024100
SCENE_UL_CORNER_MAPX = 158602.500
SCENE_UL_CORNER_MAPY = 2825917.500
SCENE_UR_CORNER_MAPX = 339264.000
SCENE_UR_CORNER_MAPY = 2793484.500
SCENE_LL_CORNER_MAPX = 115054.500
SCENE_LL_CORNER_MAPY = 2646396.000
SCENE_LR_CORNER_MAPX = 295716.000
SCENE_LR_CORNER_MAPY = 2613963.000
BAND1_FILE_NAME = "p013r043_7t20020316_z18_nn10.tif"
BAND2_FILE_NAME = "p013r043_7t20020316_z18_nn20.tif"
BAND3_FILE_NAME = "p013r043_7t20020316_z18_nn30.tif"
BAND4_FILE_NAME = "p013r043_7t20020316_z18_nn40.tif"
BAND5_FILE_NAME = "p013r043_7t20020316_z18_nn50.tif"
BAND61_FILE_NAME = "p013r043_7k20020316_z18_nn61.tif"
BAND62_FILE_NAME = "p013r043_7k20020316_z18_nn62.tif"
BAND7_FILE_NAME = "p013r043_7t20020316_z18_nn70.tif"
BAND8_FILE_NAME = "p013r043_7p20020316_z18_nn80.tif"
GROUP = PROJECTION_PARAMETERS
REFERENCE_DATUM = "WGS84"
REFERENCE_ELLIPSOID = "WGS84"
GRID_CELL_ORIGIN = "Center"
UL_GRID_LINE_NUMBER = 1
UL_GRID_SAMPLE_NUMBER = 1
GRID_INCREMENT_UNIT = "Meters"
GRID_CELL_SIZE_PAN = 14.250
GRID_CELL_SIZE_THM = 57.000
GRID_CELL_SIZE_REF = 28.500
FALSE_NORTHING = 0
ORIENTATION = "NUP"
RESAMPLING_OPTION = "NN"
MAP_PROJECTION = "UTM"
END_GROUP = PROJECTION_PARAMETERS
GROUP = UTM_PARAMETERS


```

        ZONE_NUMBER = +18
    END_GROUP = UTM_PARAMETERS
    SUN_AZIMUTH = 129.7550819
    SUN_ELEVATION = 52.1636312
    QA_PERCENT_MISSING_DATA = 66
    CLOUD_COVER = 0
    PRODUCT_SAMPLES_PAN = 17490
    PRODUCT_LINES_PAN = 15864
    PRODUCT_SAMPLES_REF = 8745
    PRODUCT_LINES_REF = 7932
    PRODUCT_SAMPLES_THM = 4373
    PRODUCT_LINES_THM = 3966
    OUTPUT_FORMAT = "GEOTIFF"
END_GROUP = ORTHO_PRODUCT_METADATA
GROUP = L1G_PRODUCT_METADATA
    BAND_COMBINATION = "123456678"
    CPF_FILE_NAME = "L7CPF20020101_20020331_04"
    GROUP = MIN_MAX_RADIANCE
        LMAX_BAND1 = 191.600
        LMIN_BAND1 = -6.200
        LMAX_BAND2 = 196.500
        LMIN_BAND2 = -6.400
        LMAX_BAND3 = 152.900
        LMIN_BAND3 = -5.000
        LMAX_BAND4 = 241.100
        LMIN_BAND4 = -5.100
        LMAX_BAND5 = 31.060
        LMIN_BAND5 = -1.000
        LMAX_BAND61 = 17.040
        LMIN_BAND61 = 0.000
        LMAX_BAND62 = 12.650
        LMIN_BAND62 = 3.200
        LMAX_BAND7 = 10.800
        LMIN_BAND7 = -0.350
        LMAX_BAND8 = 243.100
        LMIN_BAND8 = -4.700
    END_GROUP = MIN_MAX_RADIANCE
    GROUP = MIN_MAX_PIXEL_VALUE
        QCALMAX_BAND1 = 255.0
        QCALMIN_BAND1 = 1.0
        QCALMAX_BAND2 = 255.0
        QCALMIN_BAND2 = 1.0
        QCALMAX_BAND3 = 255.0
        QCALMIN_BAND3 = 1.0
        QCALMAX_BAND4 = 255.0
        QCALMIN_BAND4 = 1.0
        QCALMAX_BAND5 = 255.0
        QCALMIN_BAND5 = 1.0
        QCALMAX_BAND61 = 255.0
        QCALMIN_BAND61 = 1.0
        QCALMAX_BAND62 = 255.0
        QCALMIN_BAND62 = 1.0
        QCALMAX_BAND7 = 255.0
        QCALMIN_BAND7 = 1.0
        QCALMAX_BAND8 = 255.0
        QCALMIN_BAND8 = 1.0

```



```

END_GROUP = MIN_MAX_PIXEL_VALUE
GROUP = PRODUCT_PARAMETERS
CORRECTION_METHOD_GAIN_BAND1 = "CPF"
CORRECTION_METHOD_GAIN_BAND2 = "CPF"
CORRECTION_METHOD_GAIN_BAND3 = "CPF"
CORRECTION_METHOD_GAIN_BAND4 = "CPF"
CORRECTION_METHOD_GAIN_BAND5 = "CPF"
CORRECTION_METHOD_GAIN_BAND61 = "CPF"
CORRECTION_METHOD_GAIN_BAND62 = "CPF"
CORRECTION_METHOD_GAIN_BAND7 = "CPF"
CORRECTION_METHOD_GAIN_BAND8 = "CPF"
CORRECTION_METHOD_BIAS = "IC"
BAND1_GAIN = "H"
BAND2_GAIN = "H"
BAND3_GAIN = "H"
BAND4_GAIN = "L"
BAND5_GAIN = "H"
BAND6_GAIN1 = "L"
BAND6_GAIN2 = "H"
BAND7_GAIN = "H"
BAND8_GAIN = "L"
BAND1_GAIN_CHANGE = "0"
BAND2_GAIN_CHANGE = "0"
BAND3_GAIN_CHANGE = "0"
BAND4_GAIN_CHANGE = "0"
BAND5_GAIN_CHANGE = "0"
BAND6_GAIN_CHANGE1 = "0"
BAND6_GAIN_CHANGE2 = "0"
BAND7_GAIN_CHANGE = "0"
BAND8_GAIN_CHANGE = "0"
BAND1_SL_GAIN_CHANGE = "0"

BAND2_SL_GAIN_CHANGE = "0"
BAND3_SL_GAIN_CHANGE = "0"
BAND4_SL_GAIN_CHANGE = "0"
BAND5_SL_GAIN_CHANGE = "0"
BAND6_SL_GAIN_CHANGE1 = "0"
BAND6_SL_GAIN_CHANGE2 = "0"
BAND7_SL_GAIN_CHANGE = "0"
BAND8_SL_GAIN_CHANGE = "0"
END_GROUP = PRODUCT_PARAMETERS
GROUP = CORRECTIONS_APPLIED
STRIPING_BAND1 = "NONE"
STRIPING_BAND2 = "NONE"
STRIPING_BAND3 = "NONE"
STRIPING_BAND4 = "NONE"
STRIPING_BAND5 = "NONE"
STRIPING_BAND61 = "NONE"
STRIPING_BAND62 = "NONE"
STRIPING_BAND7 = "NONE"
STRIPING_BAND8 = "NONE"
BANDING = "N"
COHERENT_NOISE = "N"
MEMORY_EFFECT = "N"
SCAN_CORRELATED_SHIFT = "N"
INOPERABLE_DETECTORS = "N"

```

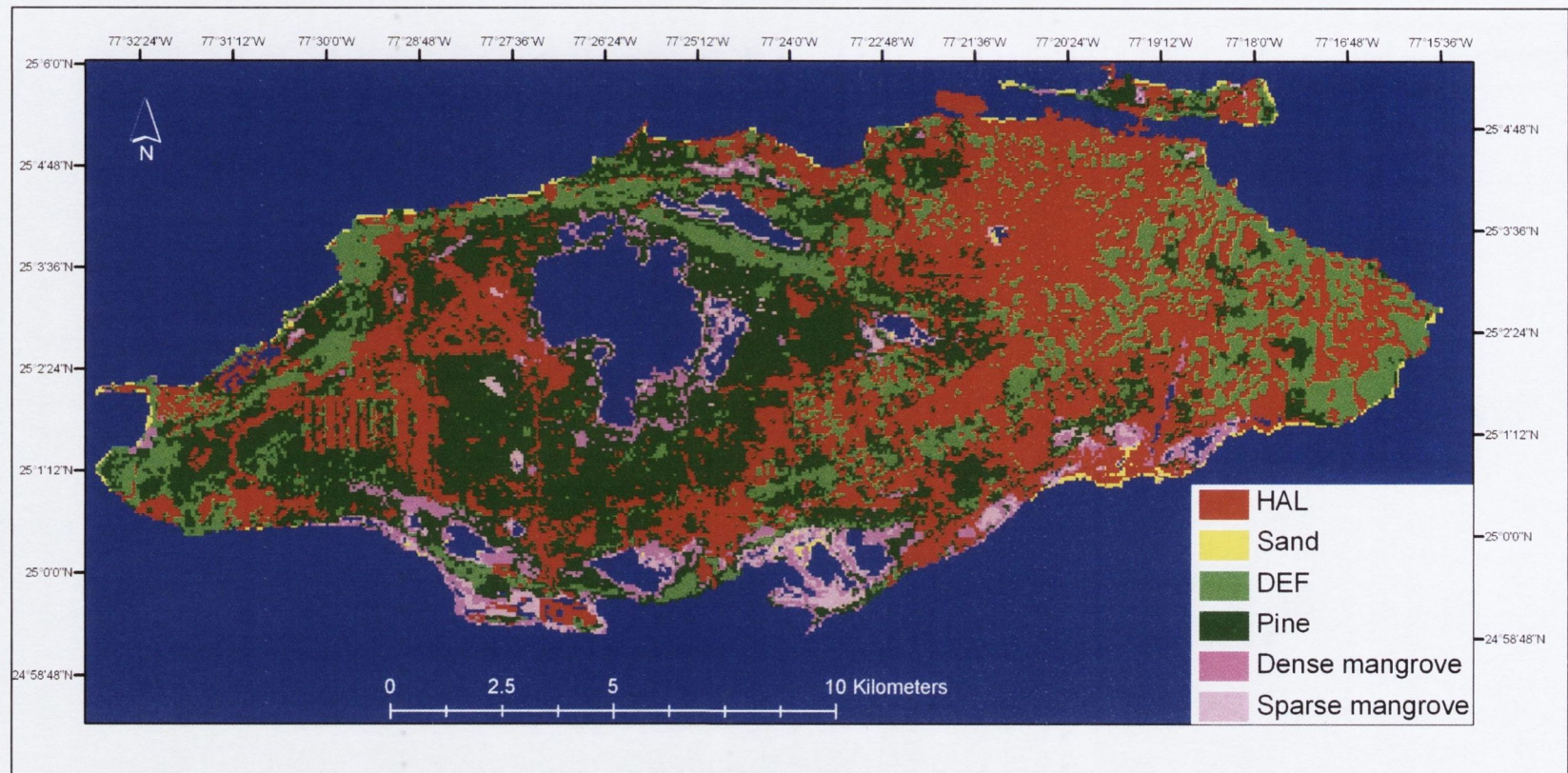

DROPPED_LINES = Y
END_GROUP = CORRECTIONS_APPLIED
END_GROUP = L1G_PRODUCT_METADATA
END_GROUP = METADATA_FILE

Appendix B

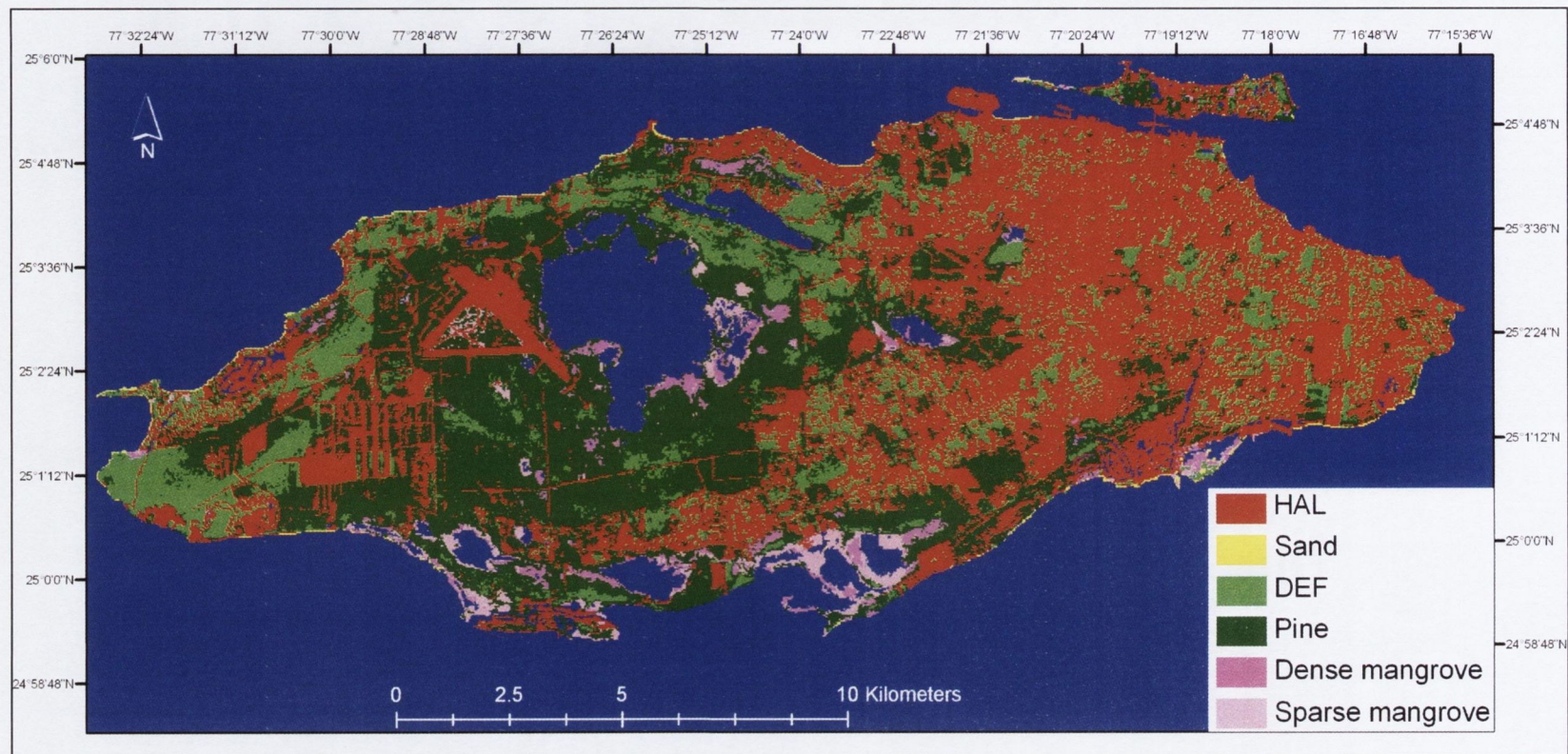
Land cover classification maps generated for New Providence Island, The Bahamas

B.1. Introduction

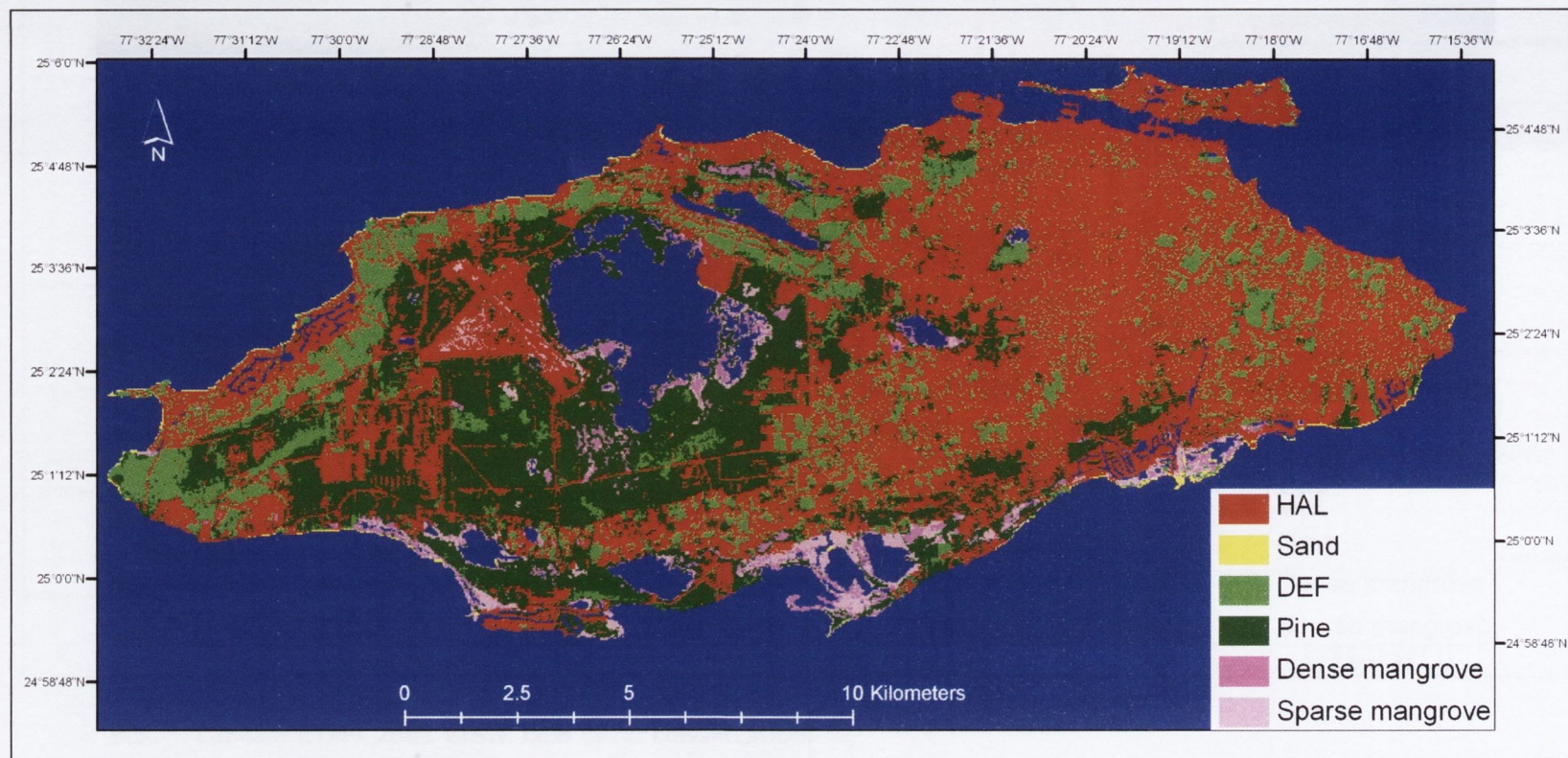
A suite of land cover classification maps developed for New Providence Island in the evaluation of ten classification methodologies undertaken as part of this research are presented in B.2 through B.31.



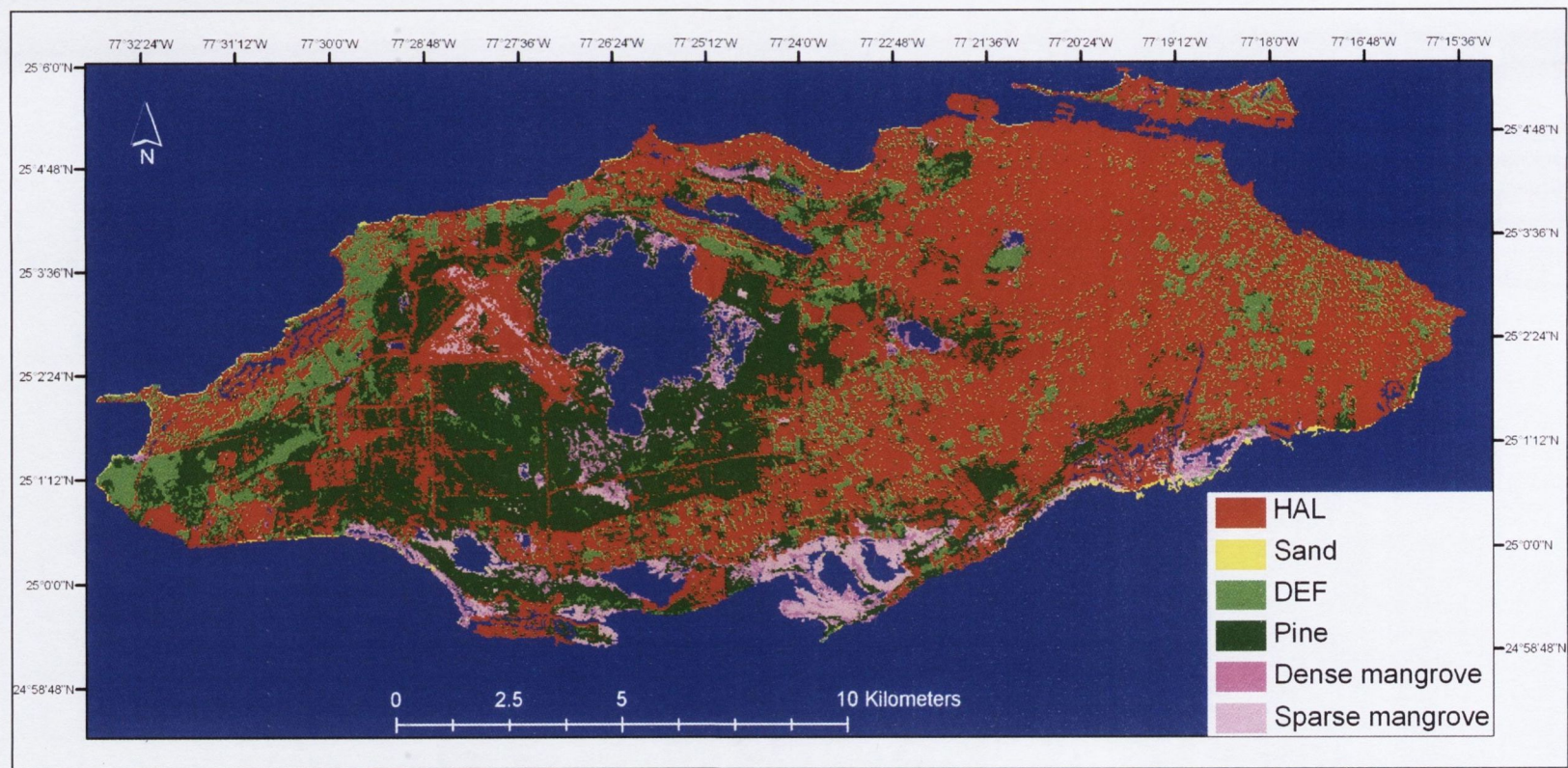
B.2. Landsat MSS 1973 VISIR land cover classification.



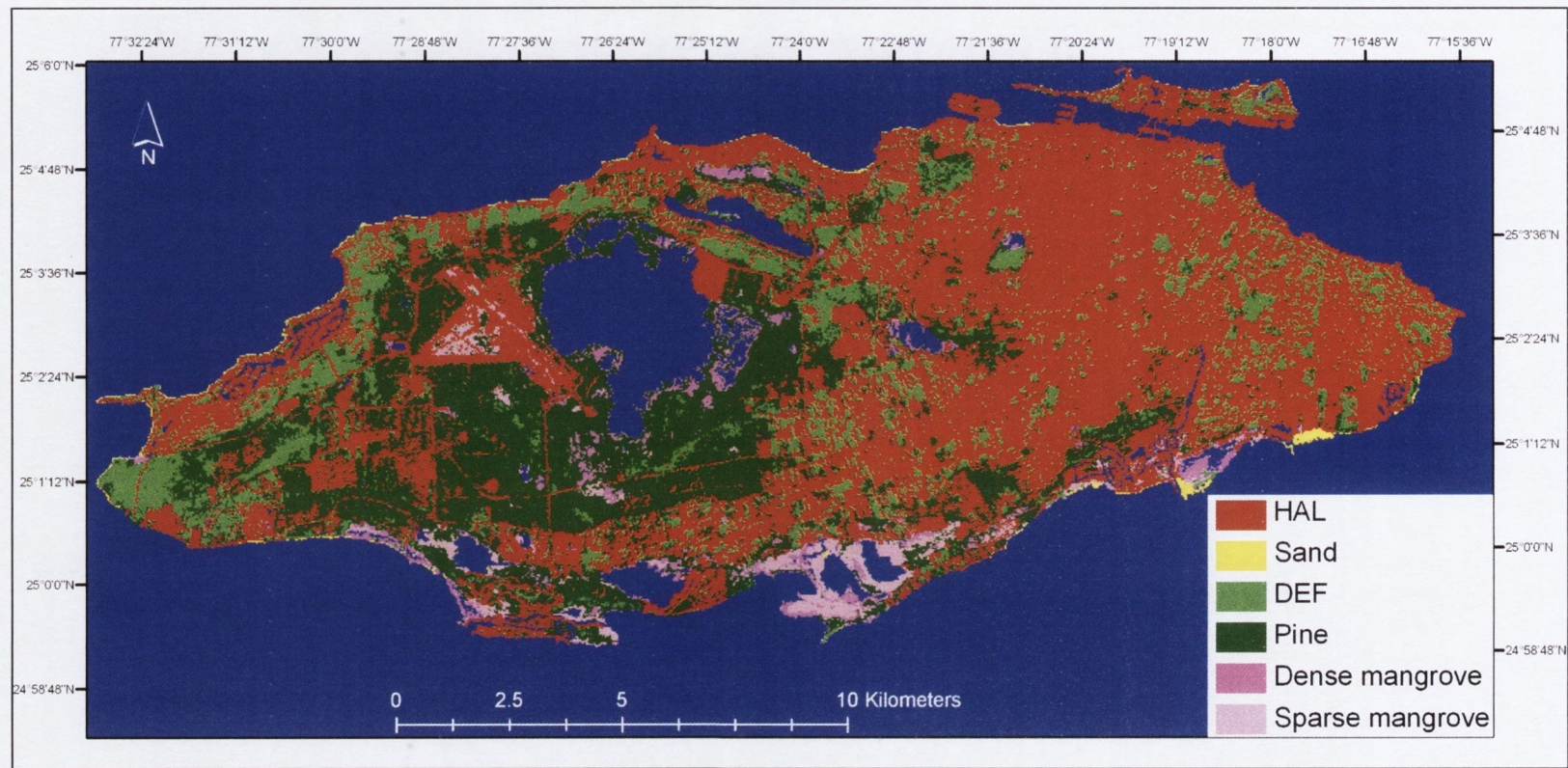
B.3. SPOT HRV 1986 VISIR land cover classification.



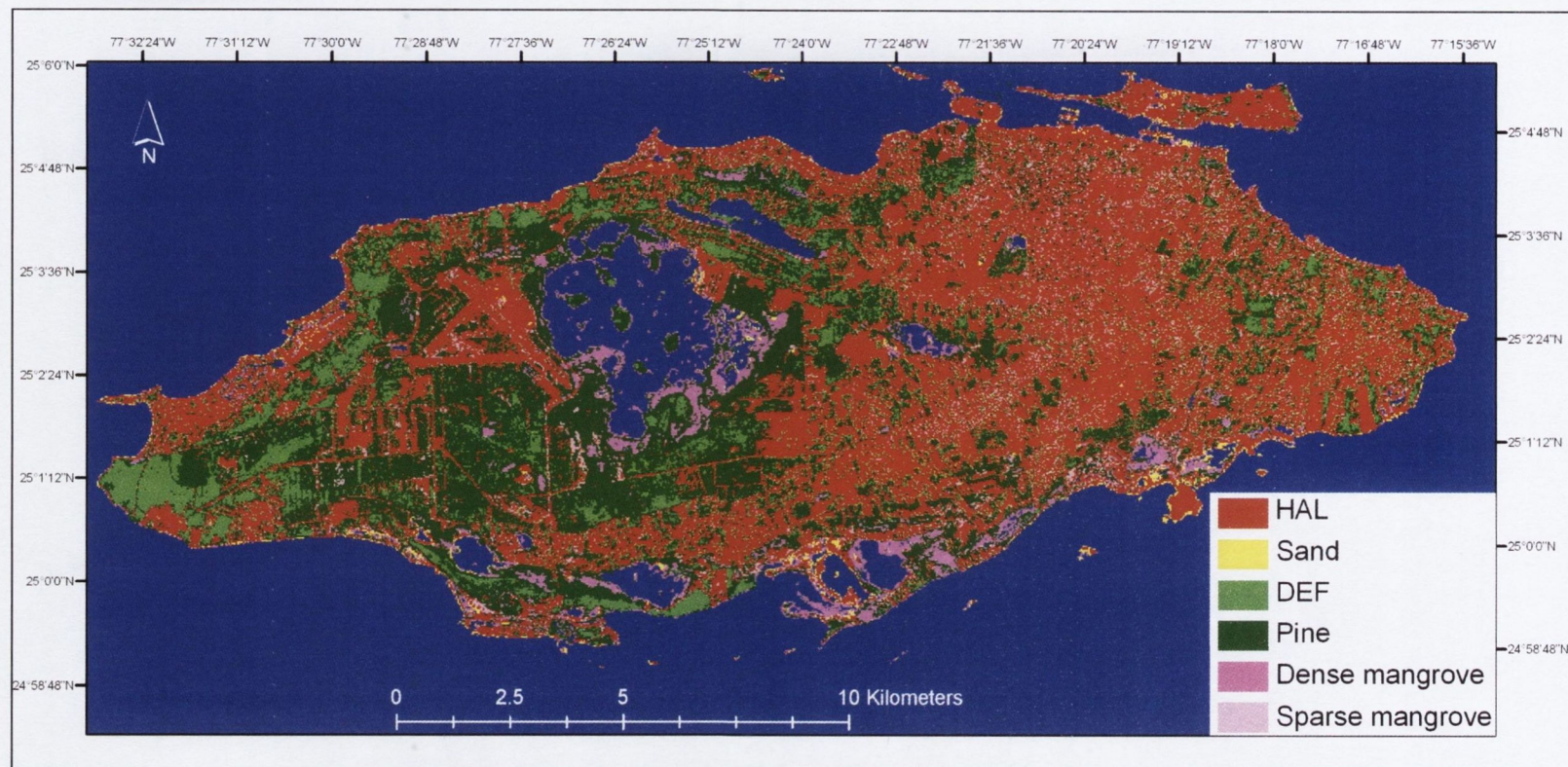
B.4. SPOT HRVIR 1999 VISIR land cover classification.



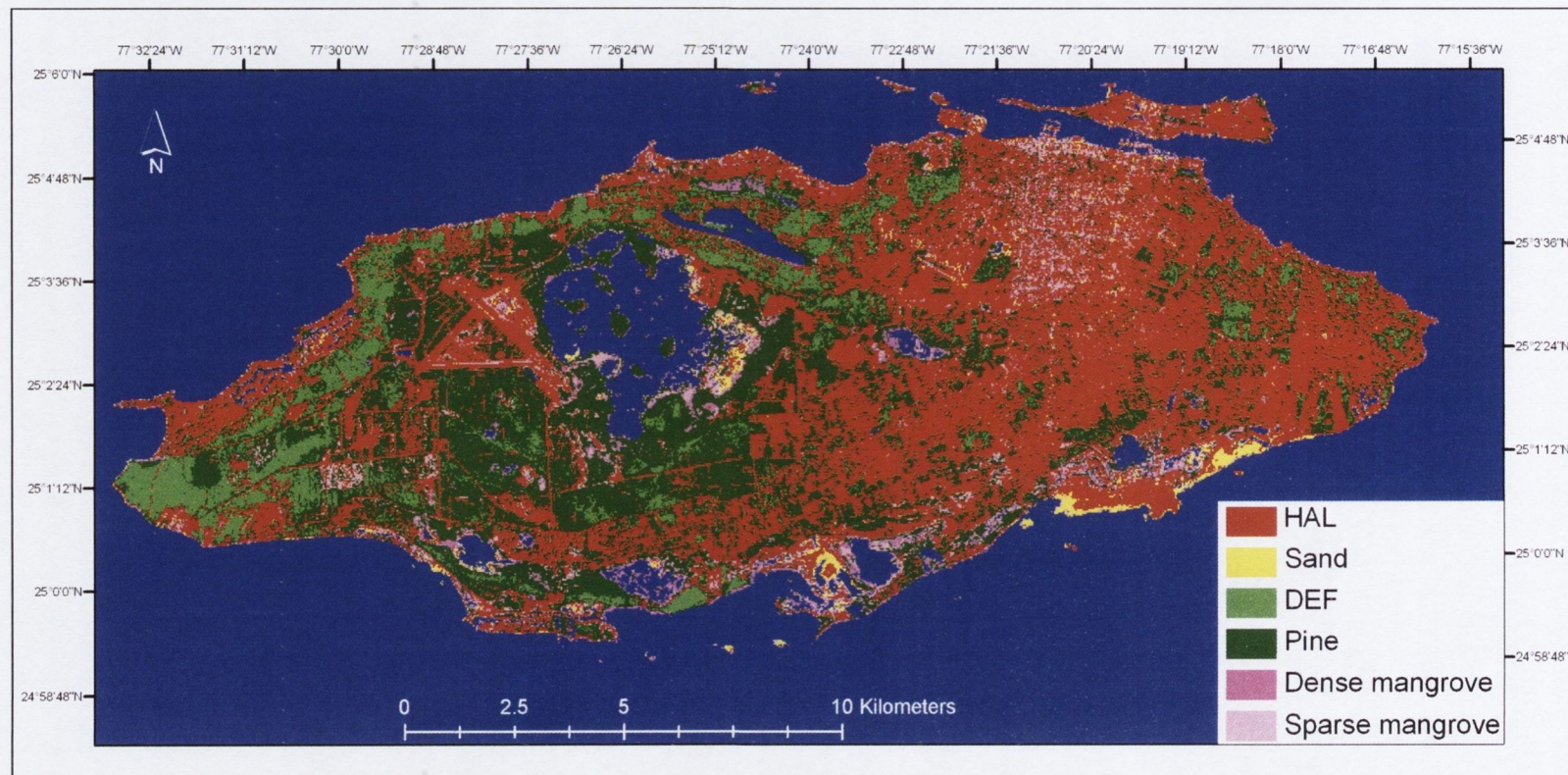
B.5. Landsat ETM+ 2001 VISIR land cover classification.



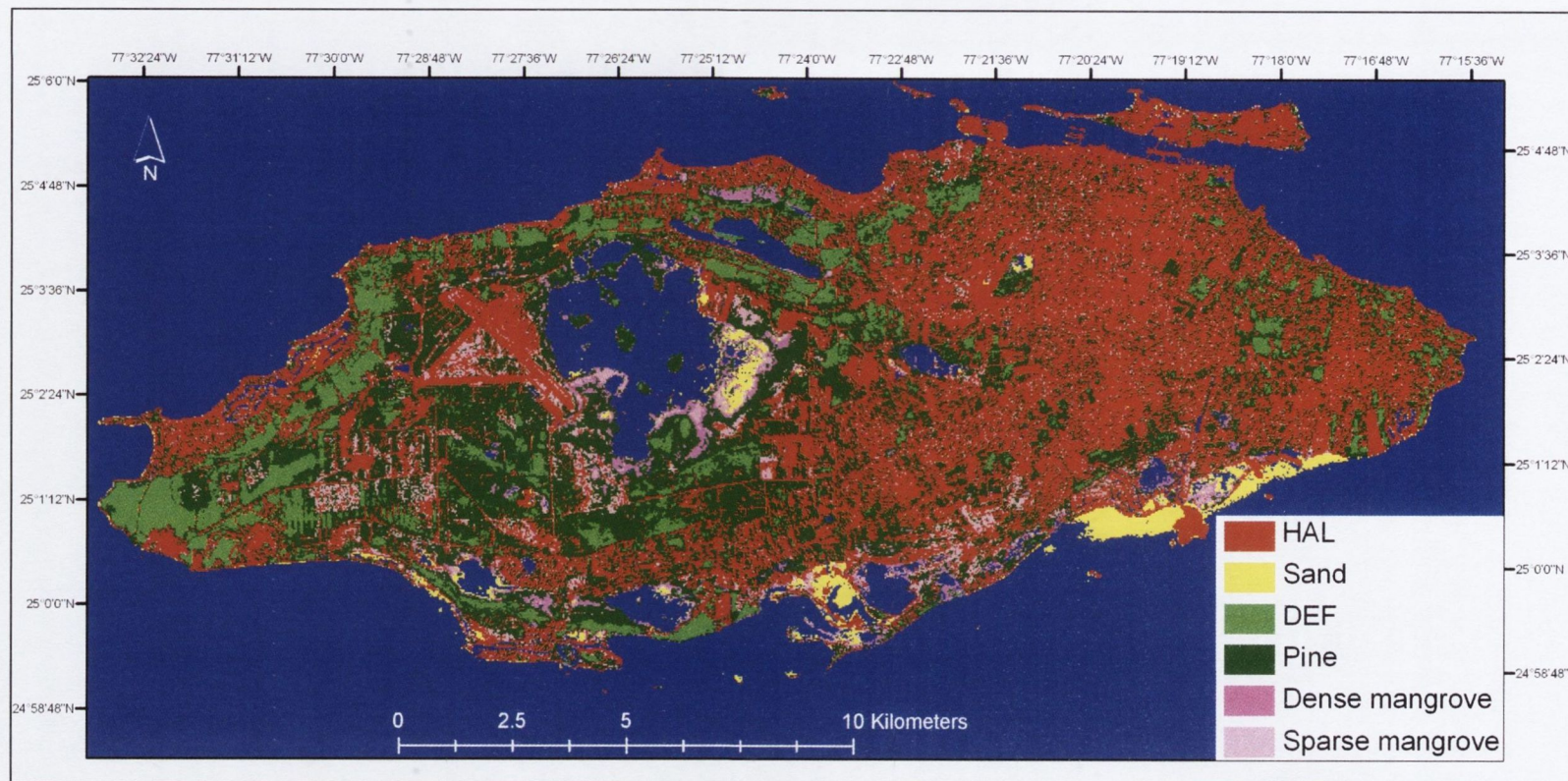
B.6. Landsat ETM+ 2002 VISIR land cover classification.



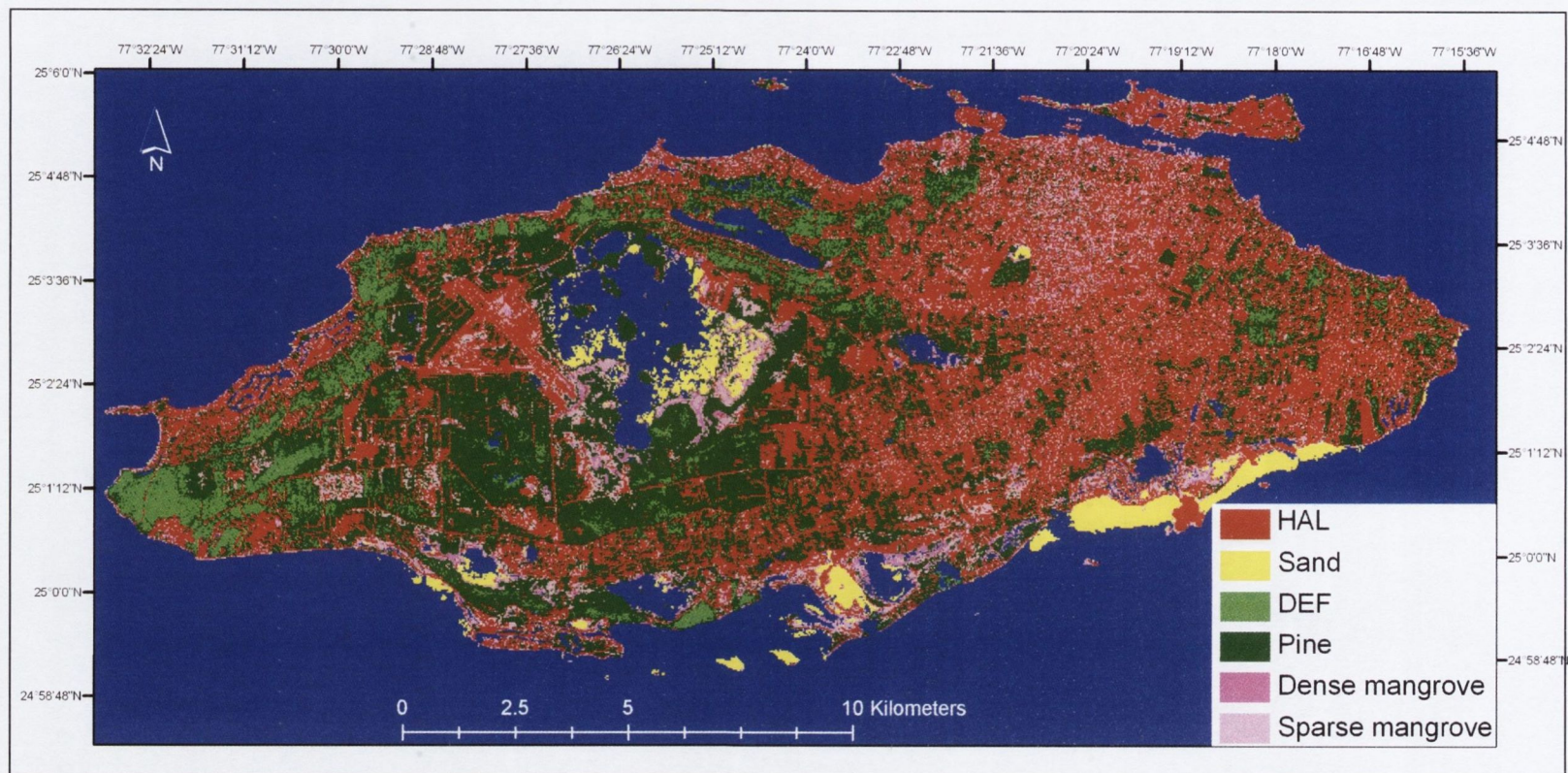
B.7. SPOT HRVIR 1999 PCA land cover classification.



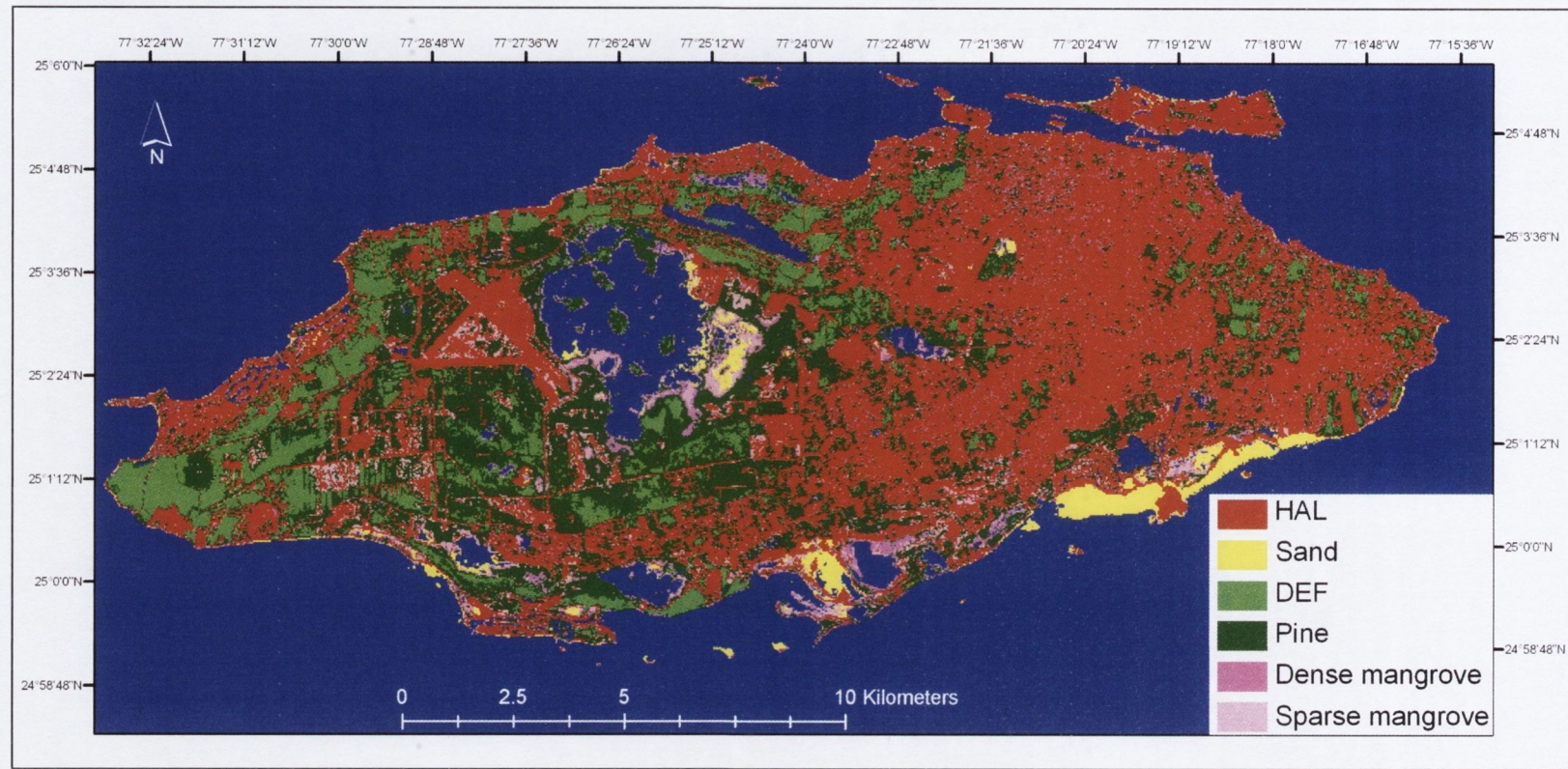
B.8. SPOT HRVIR 1999 IHS land cover classification.



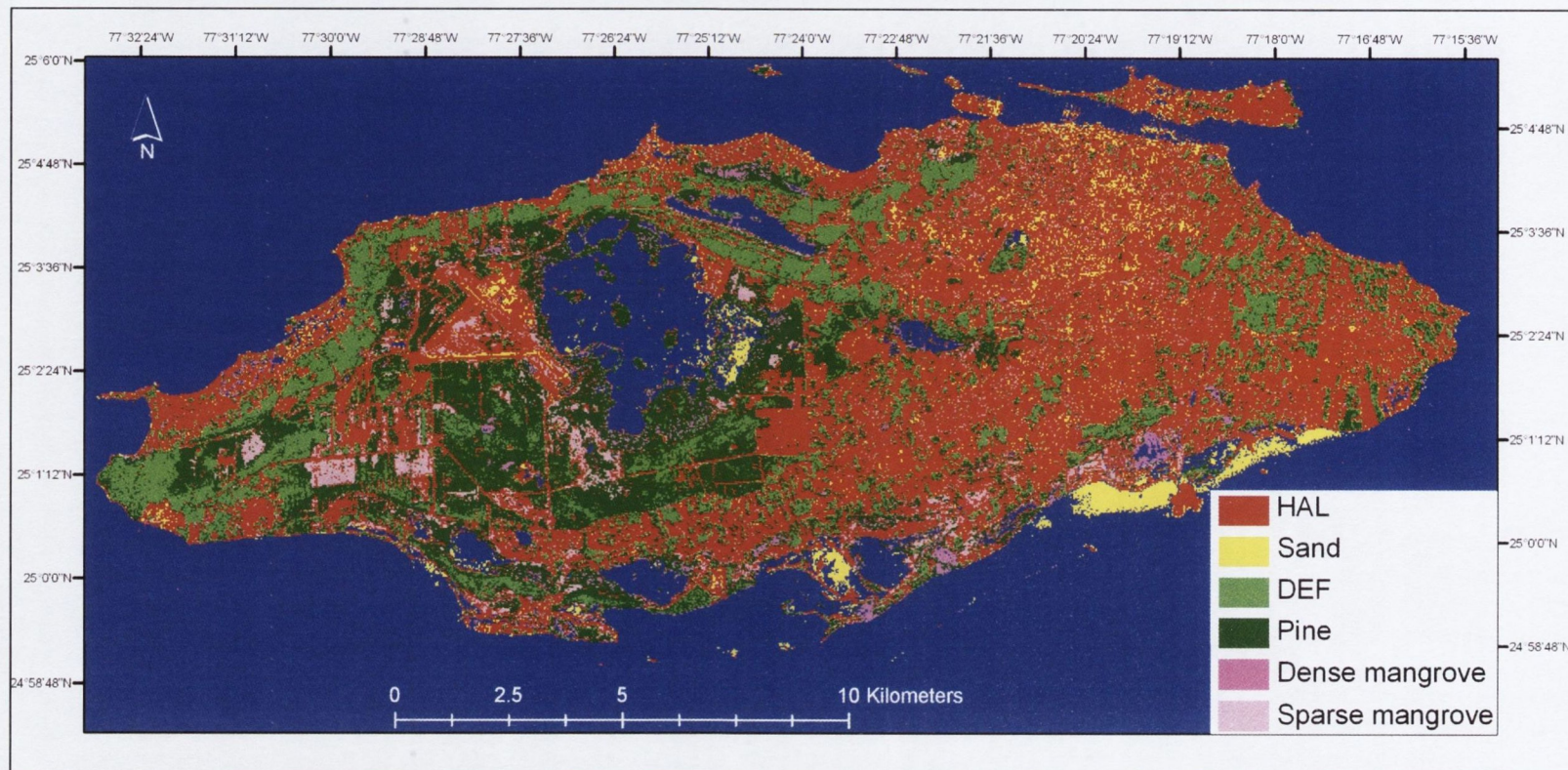
B.9. SPOT HRVIR 1999 PCA (data fusion) land cover classification.



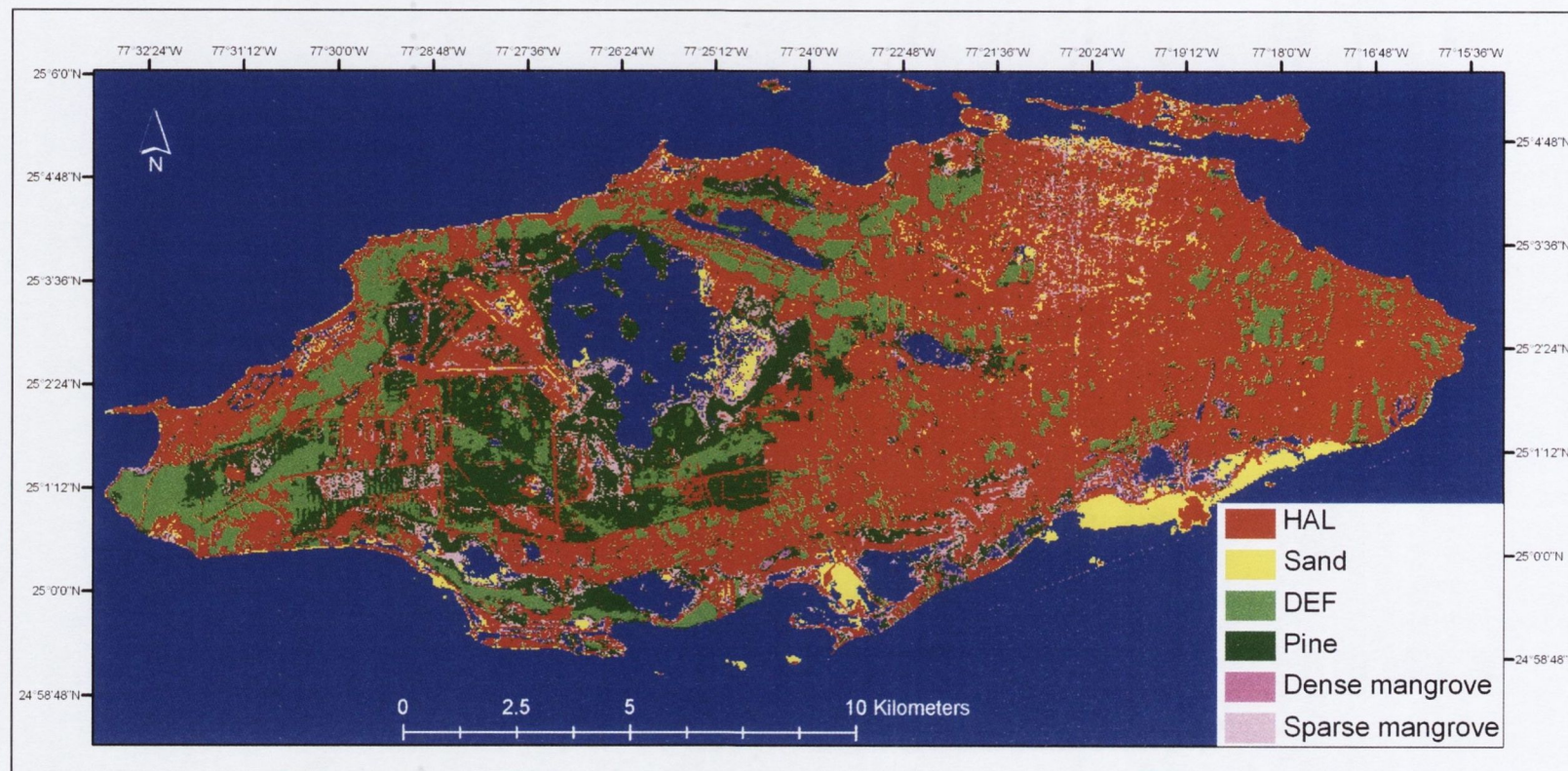
B.10. SPOT HRVIR 1999 Brovey land cover classification.



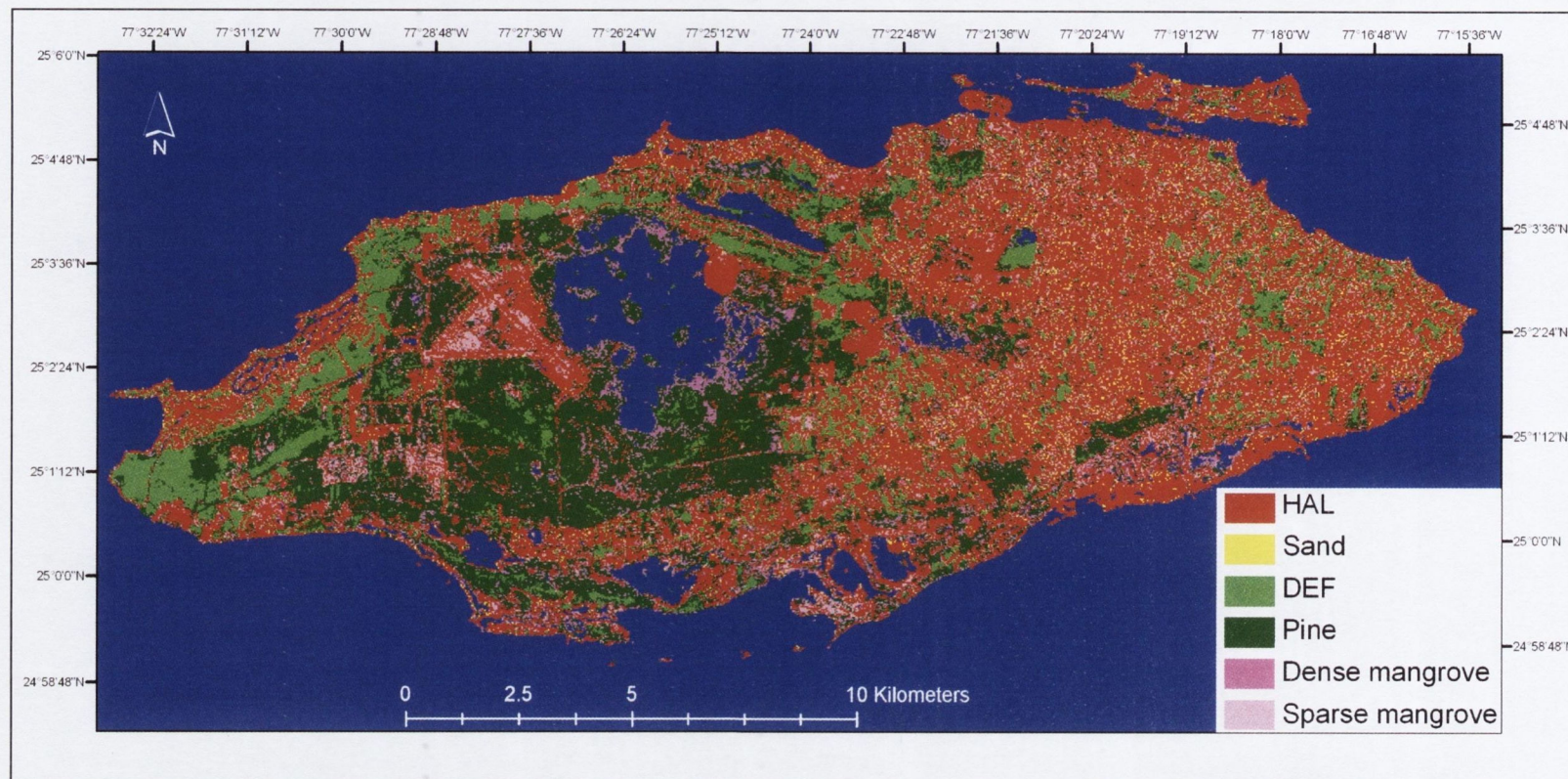
B.11. SPOT HRVIR 1999 Multiplicative land cover classification.



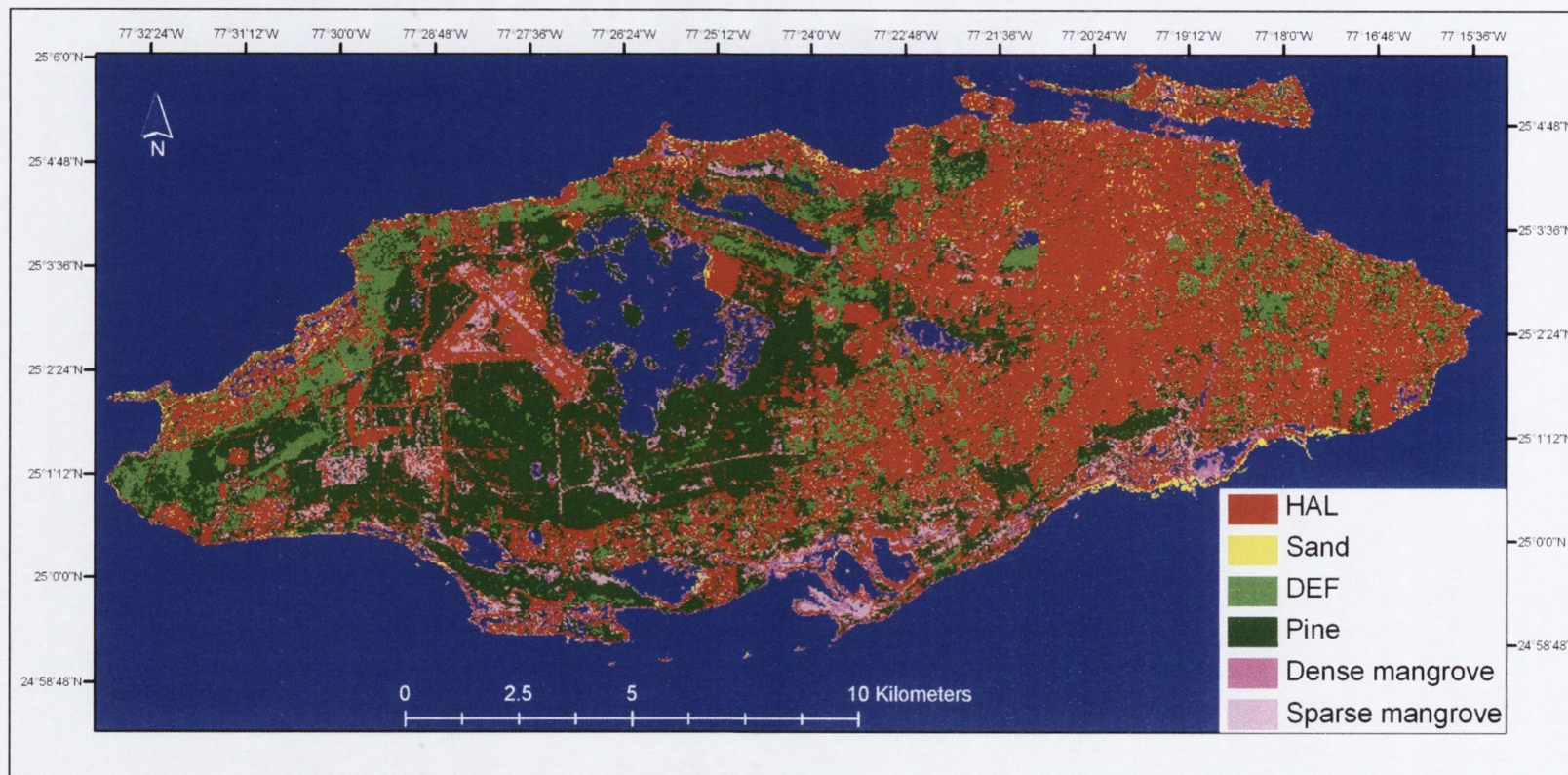
B.12. SPOT HRVIR 1999 Wavelet PCA land cover classification.



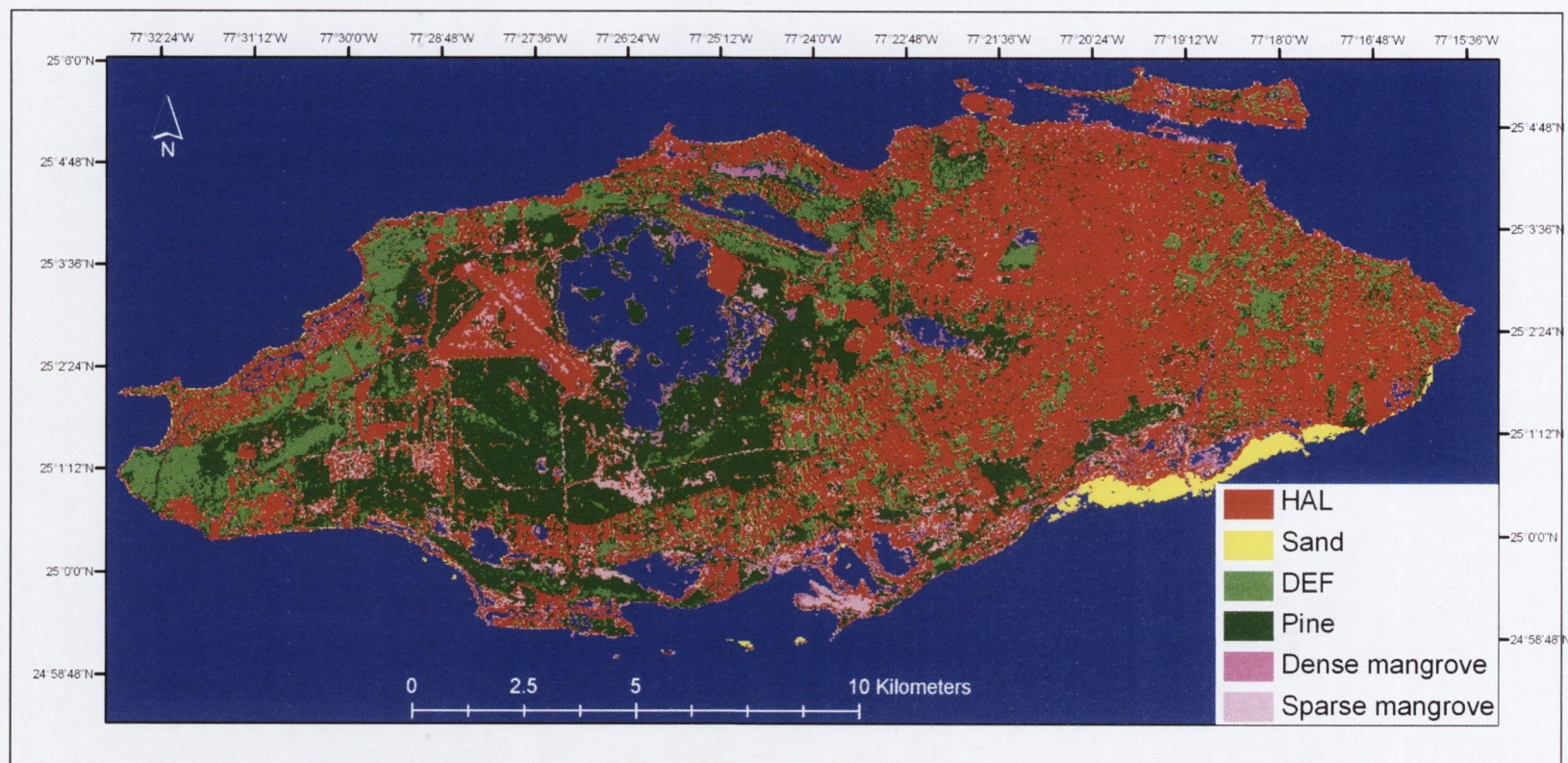
B.13. SPOT HRVIR 1999 Wavelet PCA land cover classification.



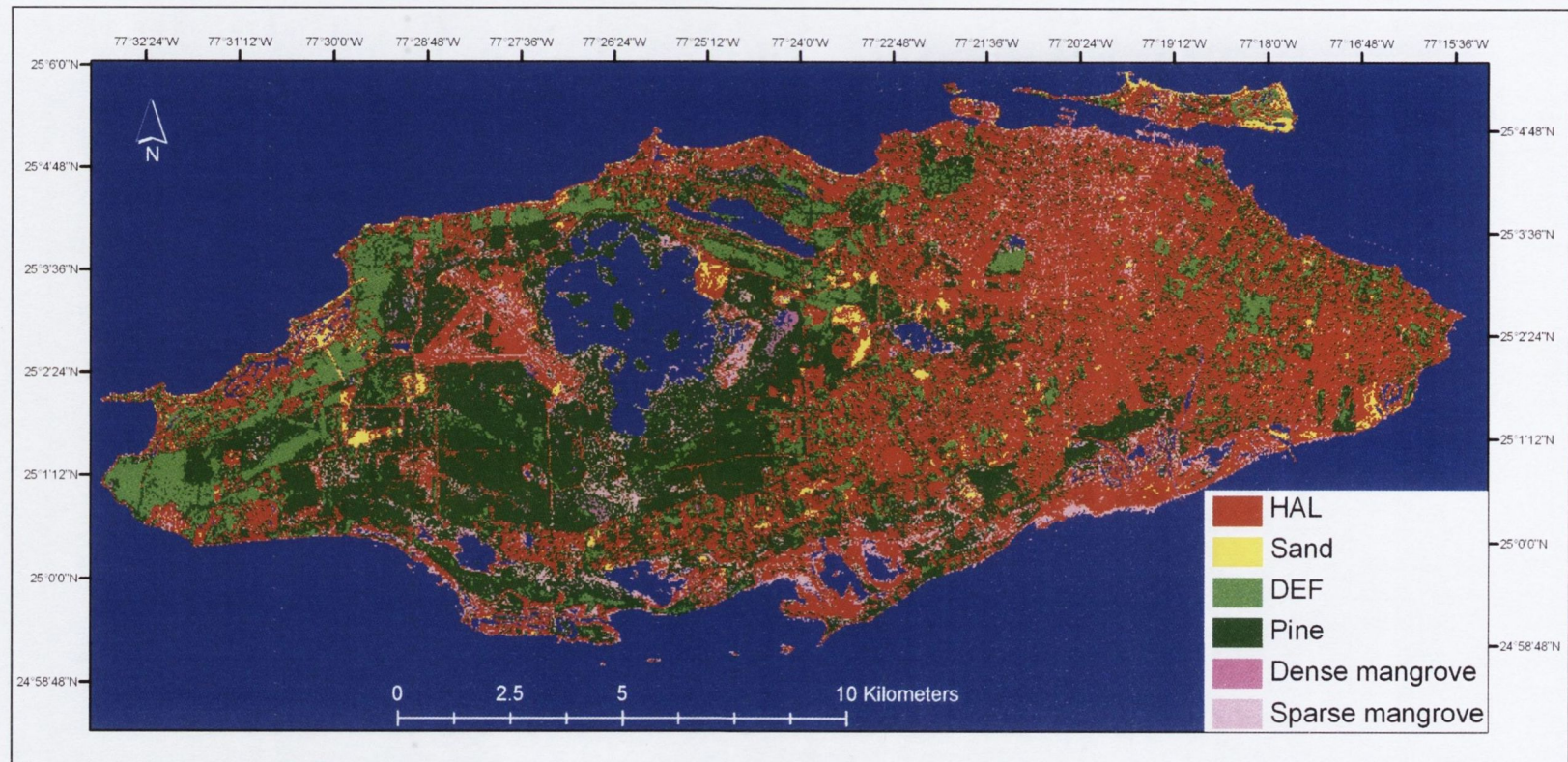
B.14. Landsat ETM+ 2001 PCA land cover classification.



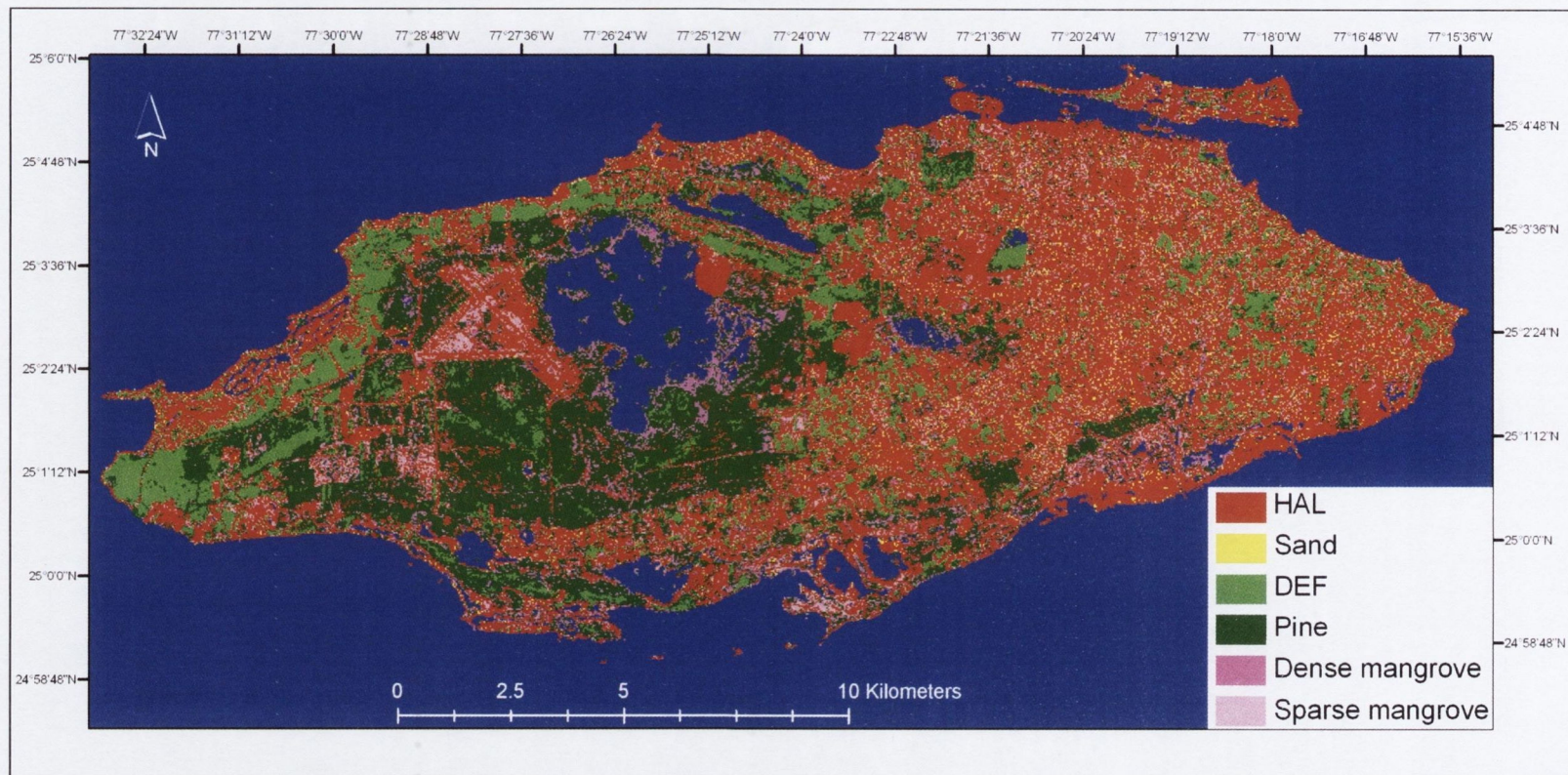
B.15. Landsat ETM+ 2001 Temp land cover classification.



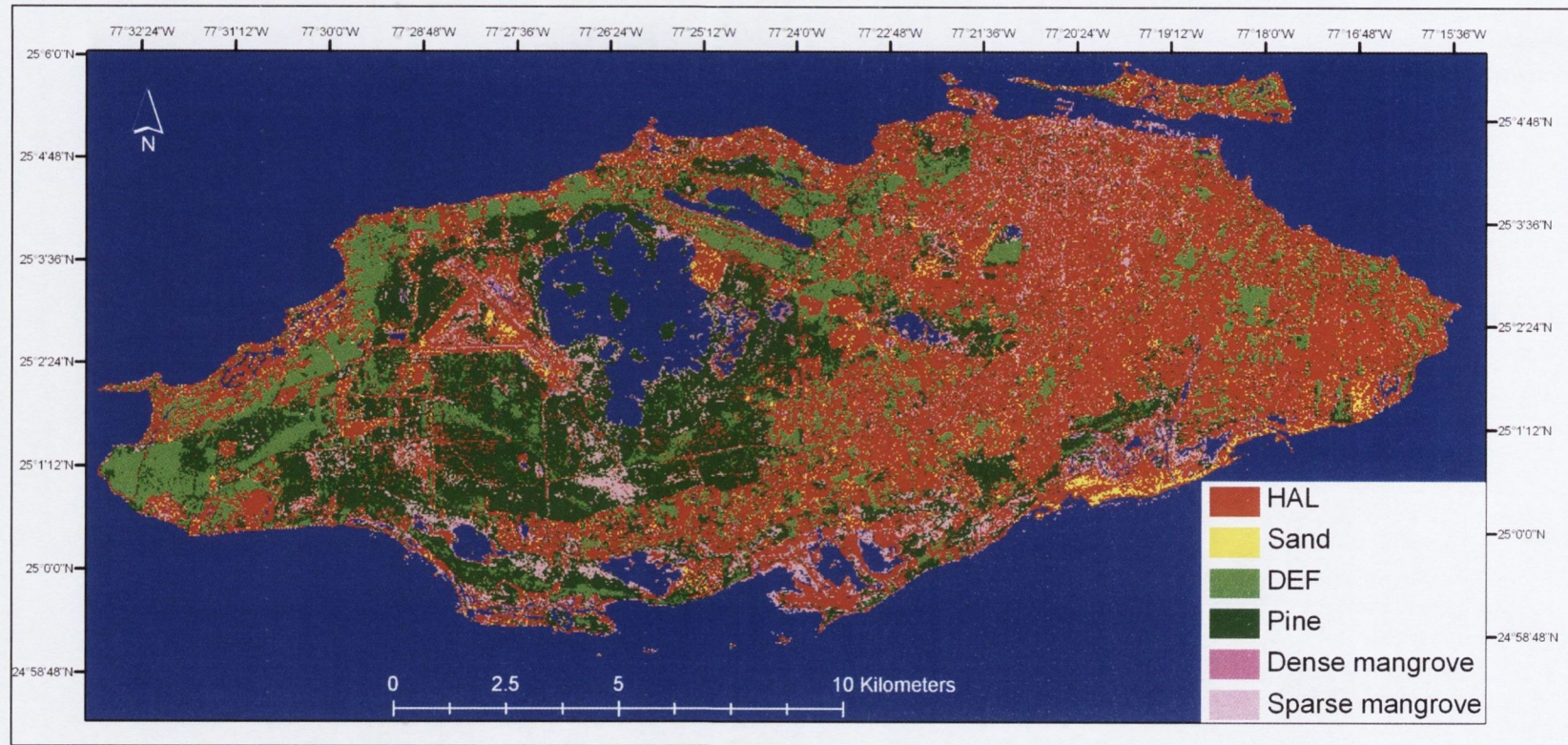
B.16. Landsat ETM+ 2001 TempPCA land cover classification.



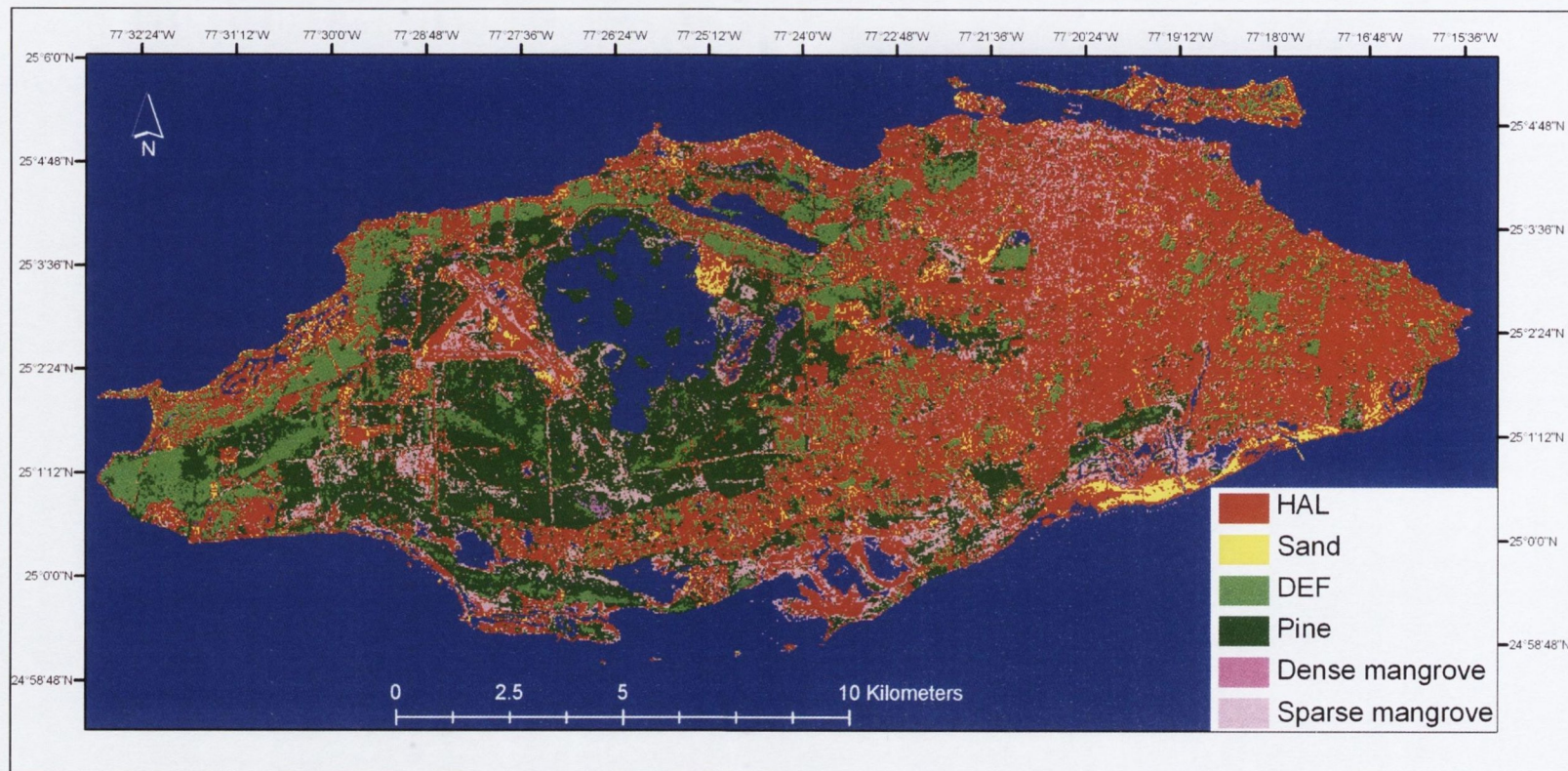
B.17. Landsat ETM+ 2001 IHS land cover classification.



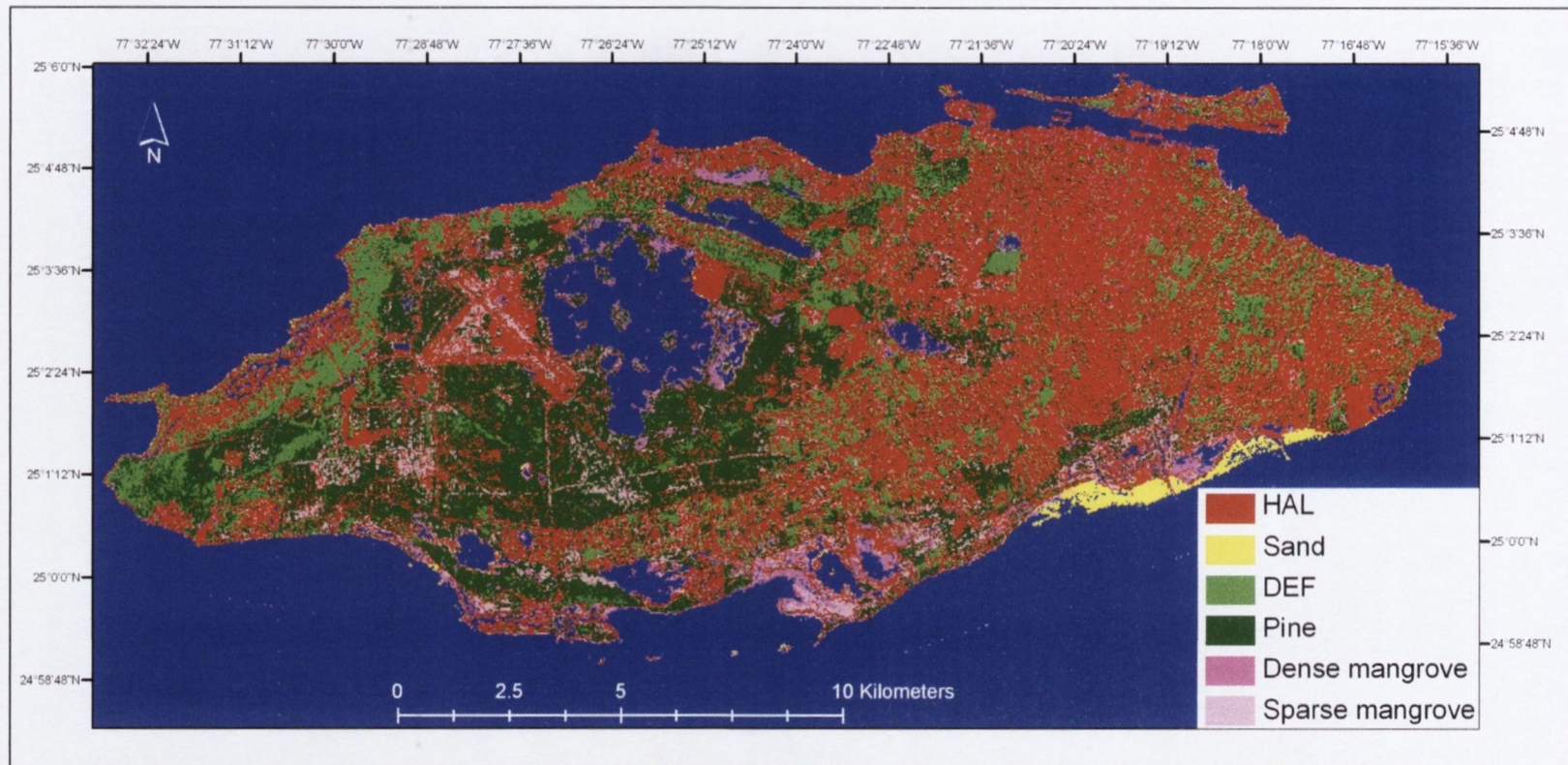
B.18. Landsat ETM+ 2001 PCA (data fusion) land cover classification.



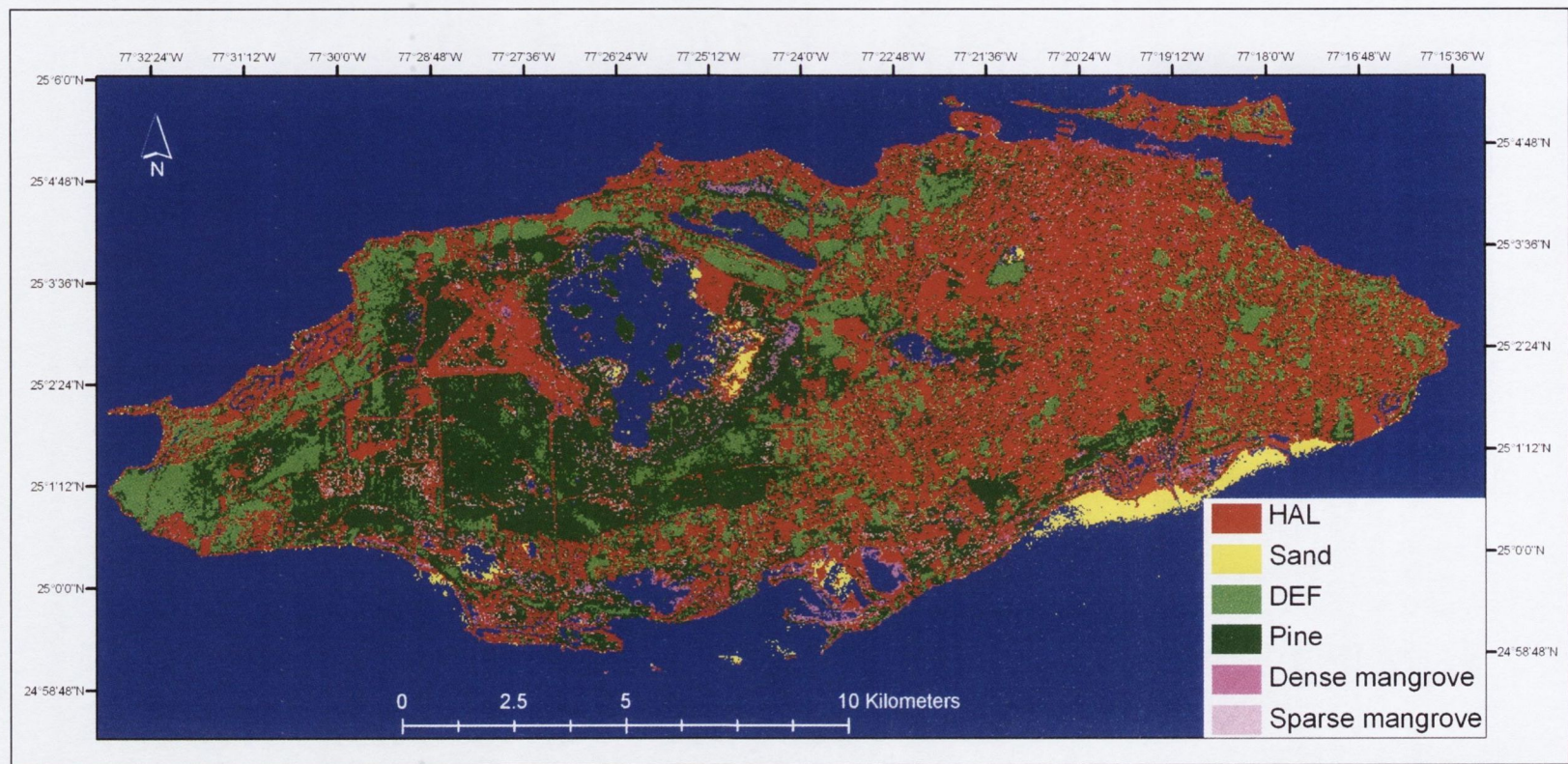
B.19. Landsat ETM+ 2001 Brovey land cover classification.



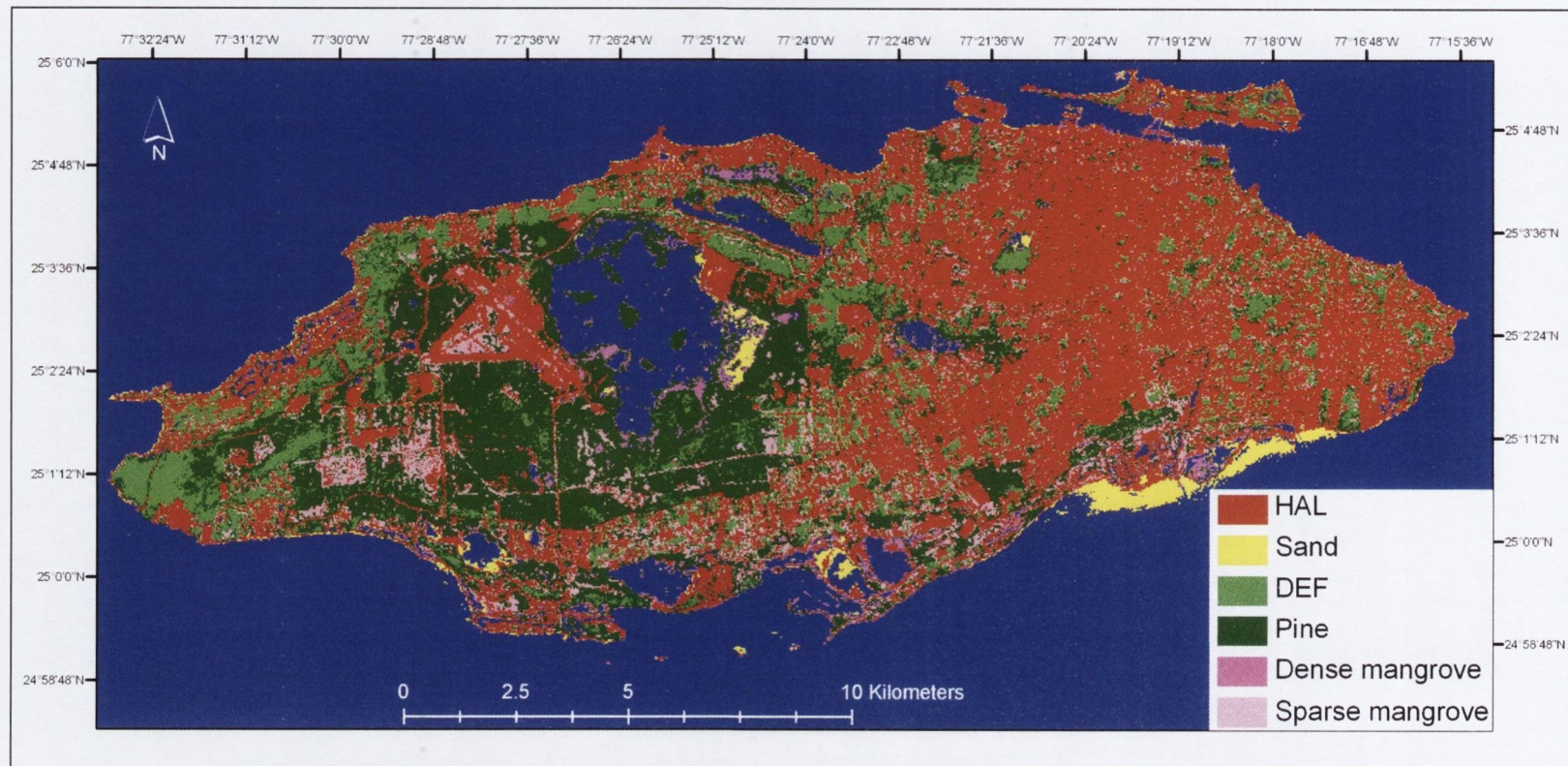
B.20. Landsat ETM+ 2001 Multiplicative land cover classification.



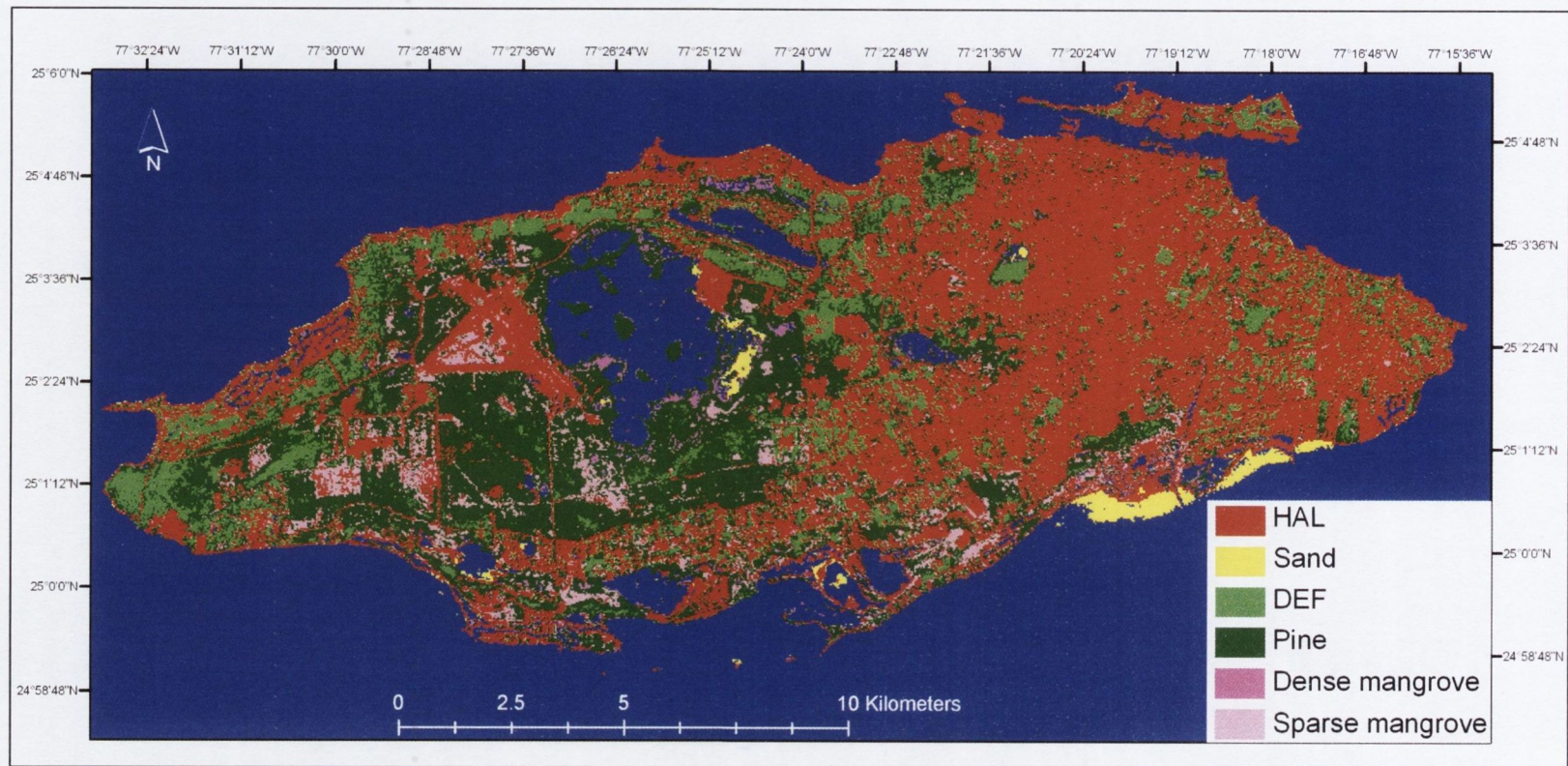
B.21. Landsat ETM+ 2001 Wavelet PCA land cover classification.



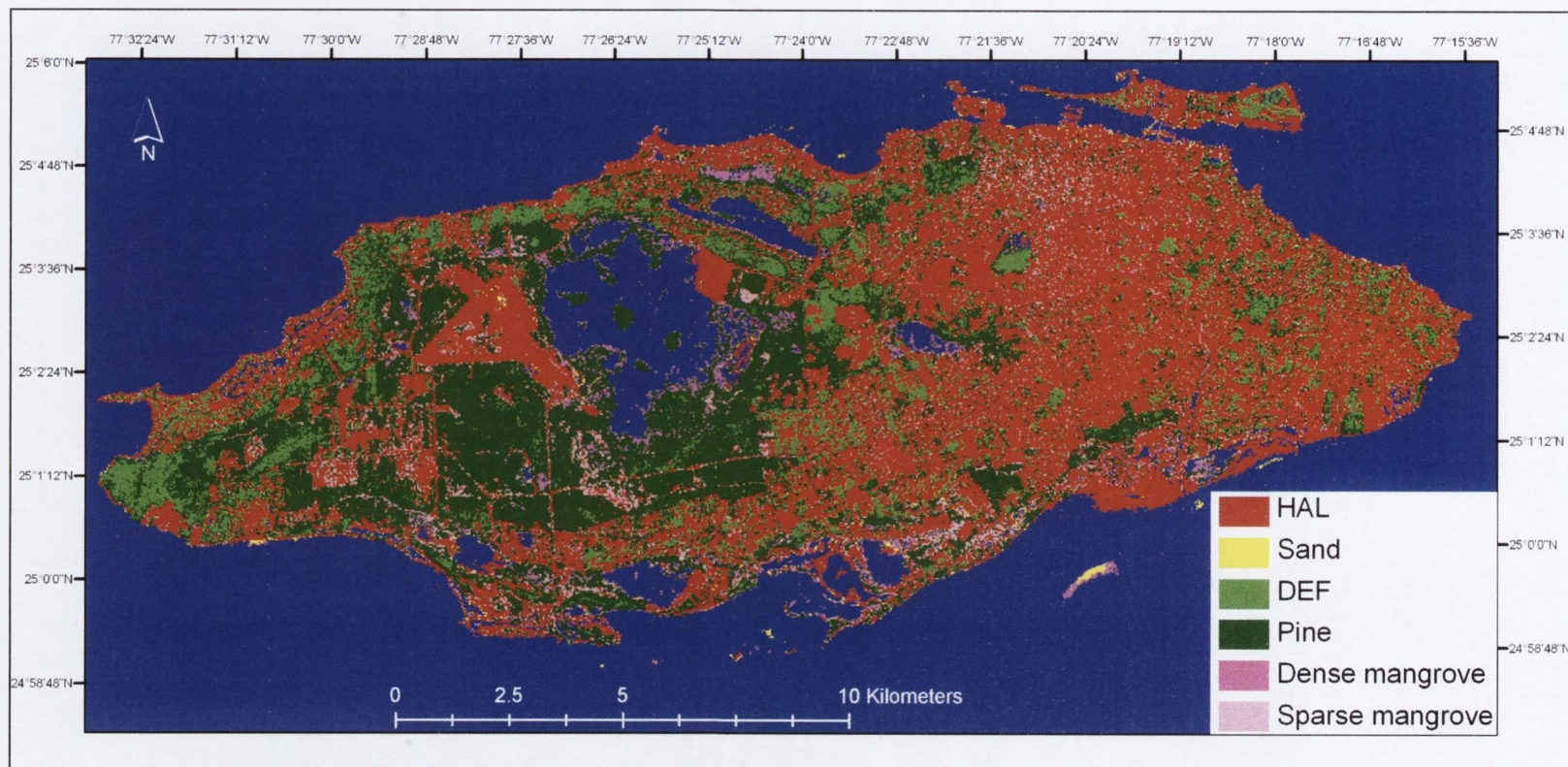
B.22. Landsat ETM+ 2001 Wavelet IHS land cover classification.



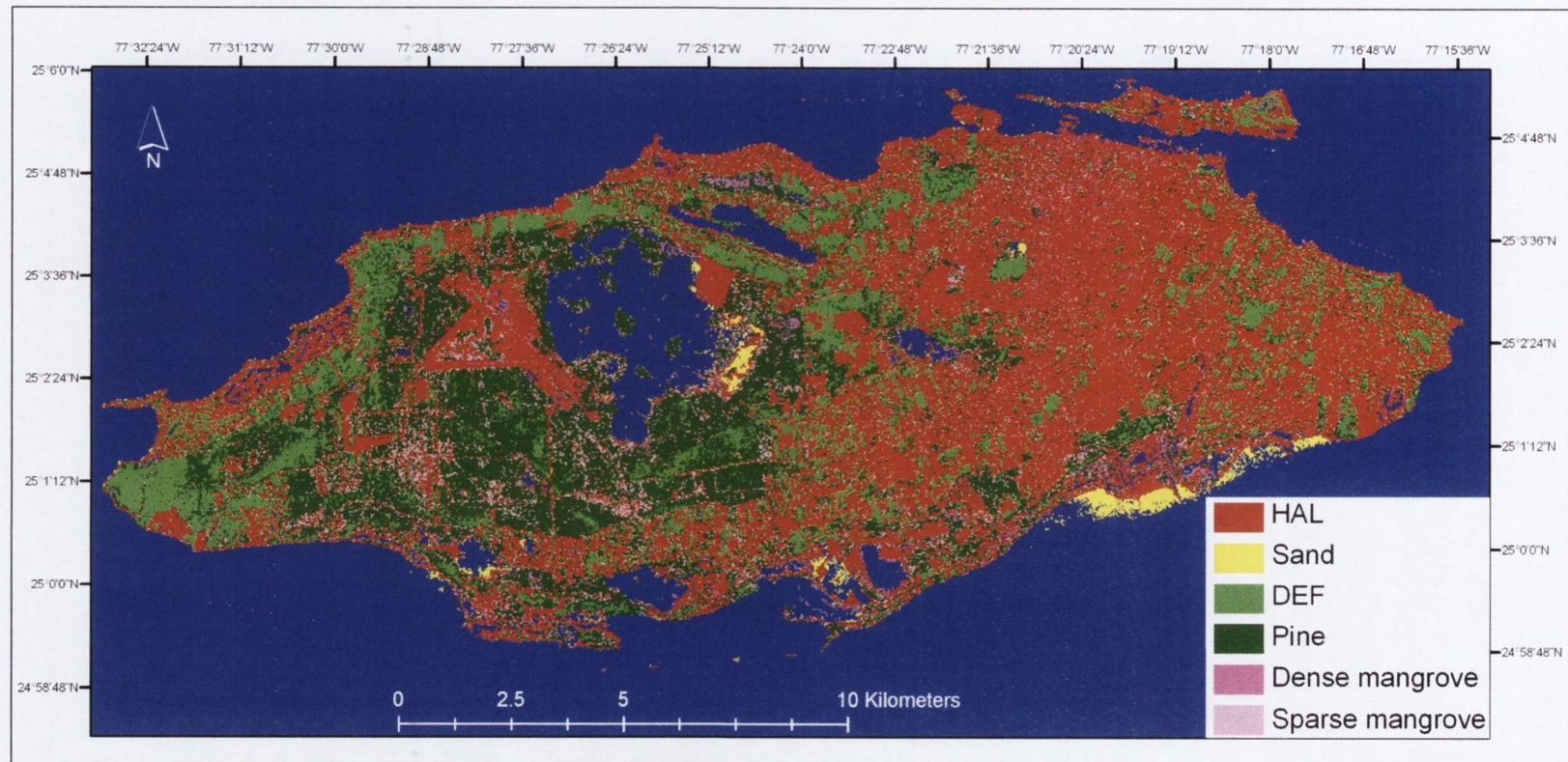
B.23. Landsat ETM+ 2002 PCA land cover classification.



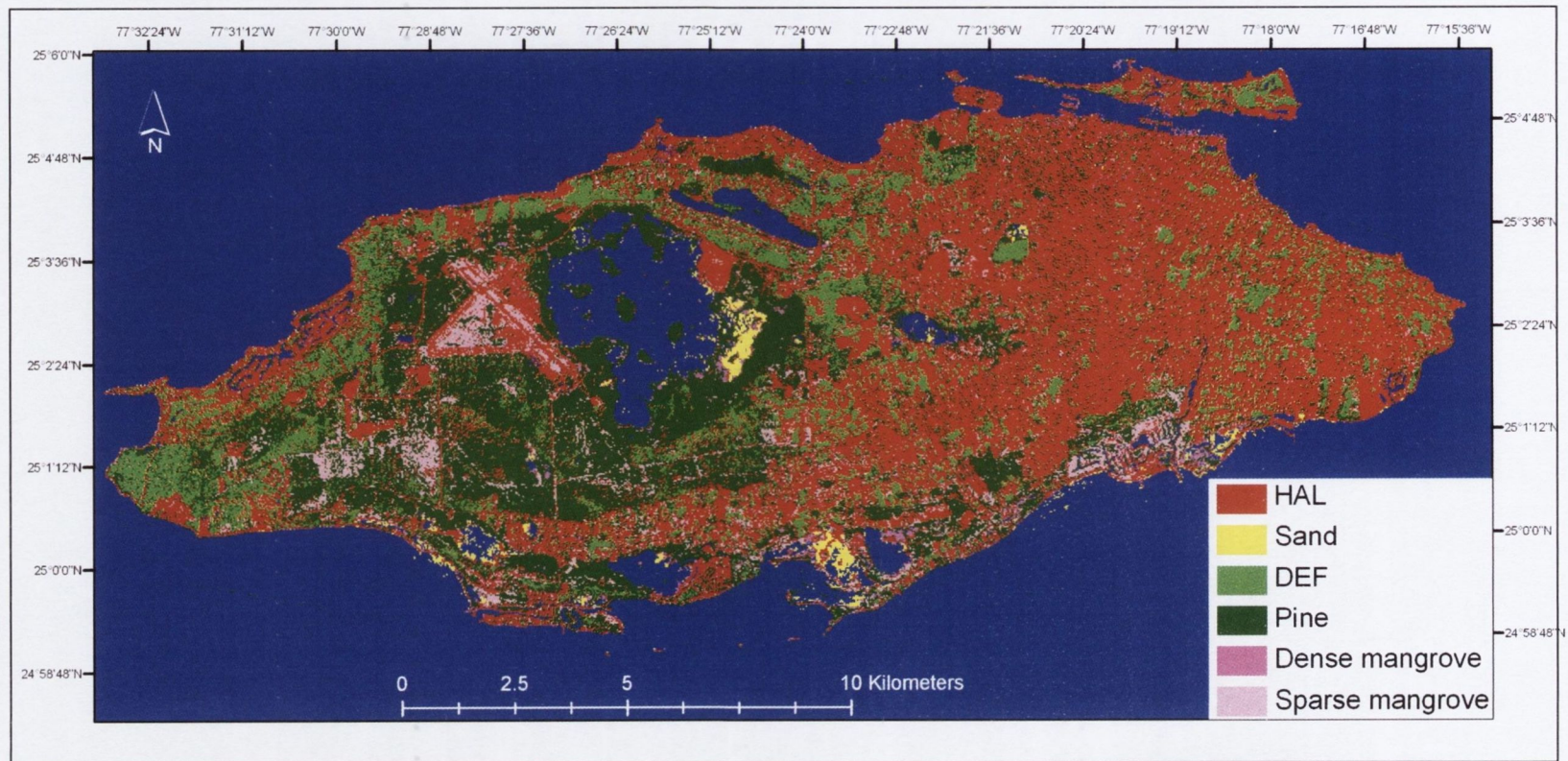
B.24. Landsat ETM+ 2002 Temp land cover classification.



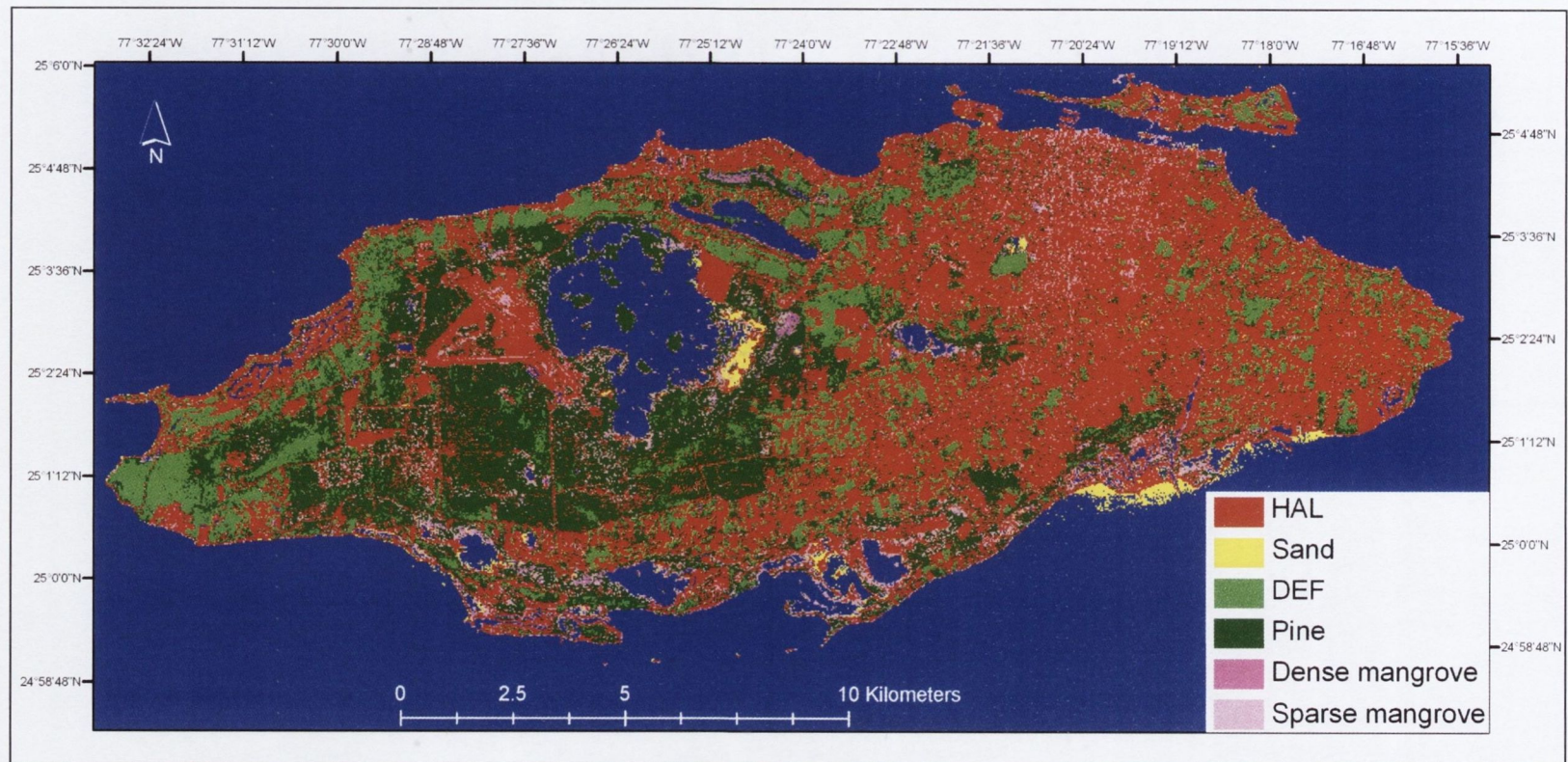
B.25. Landsat ETM+ 2002 TempPCA land cover classification.



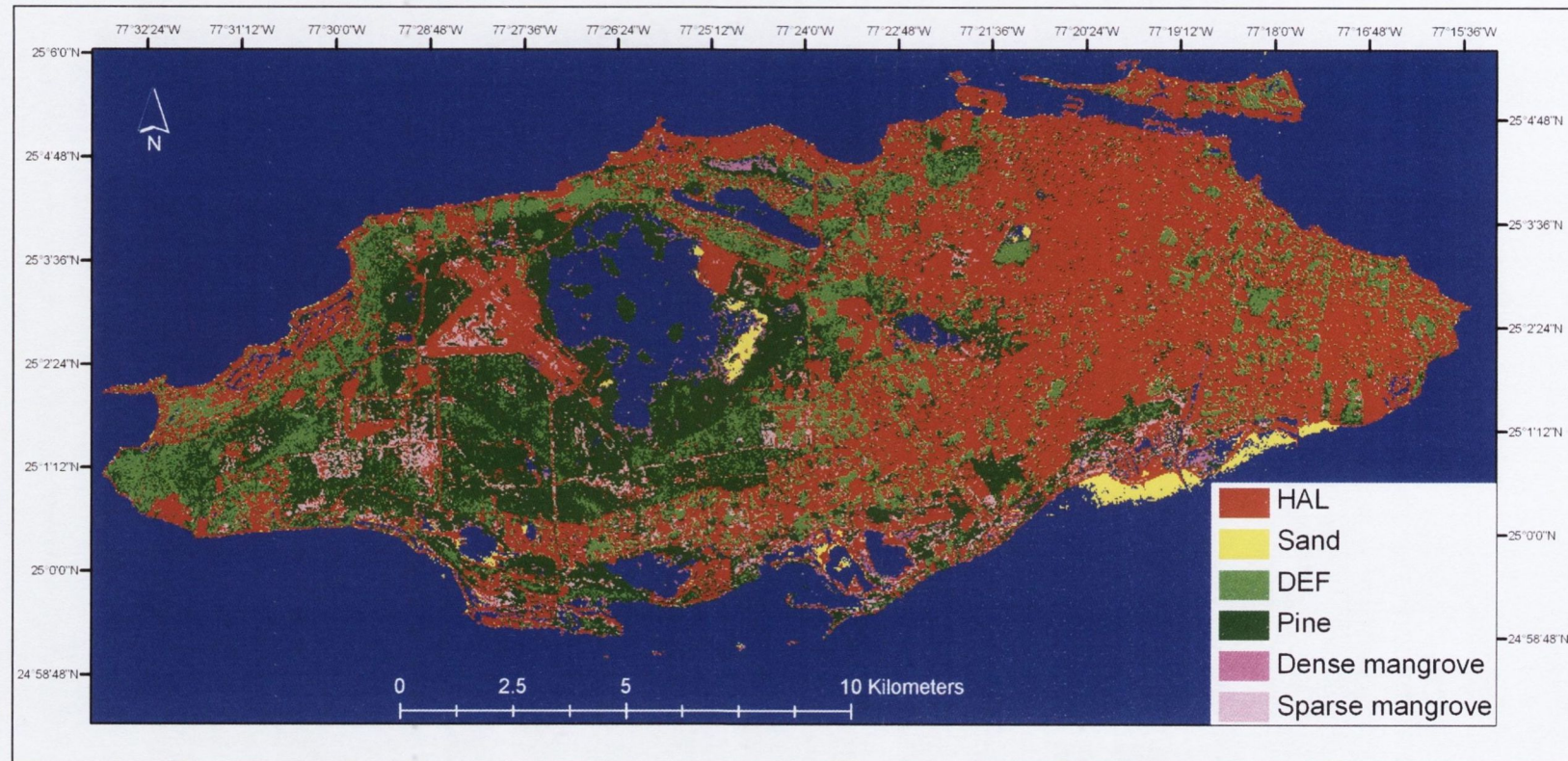
B.26. Landsat ETM+ 2002 IHS land cover classification.



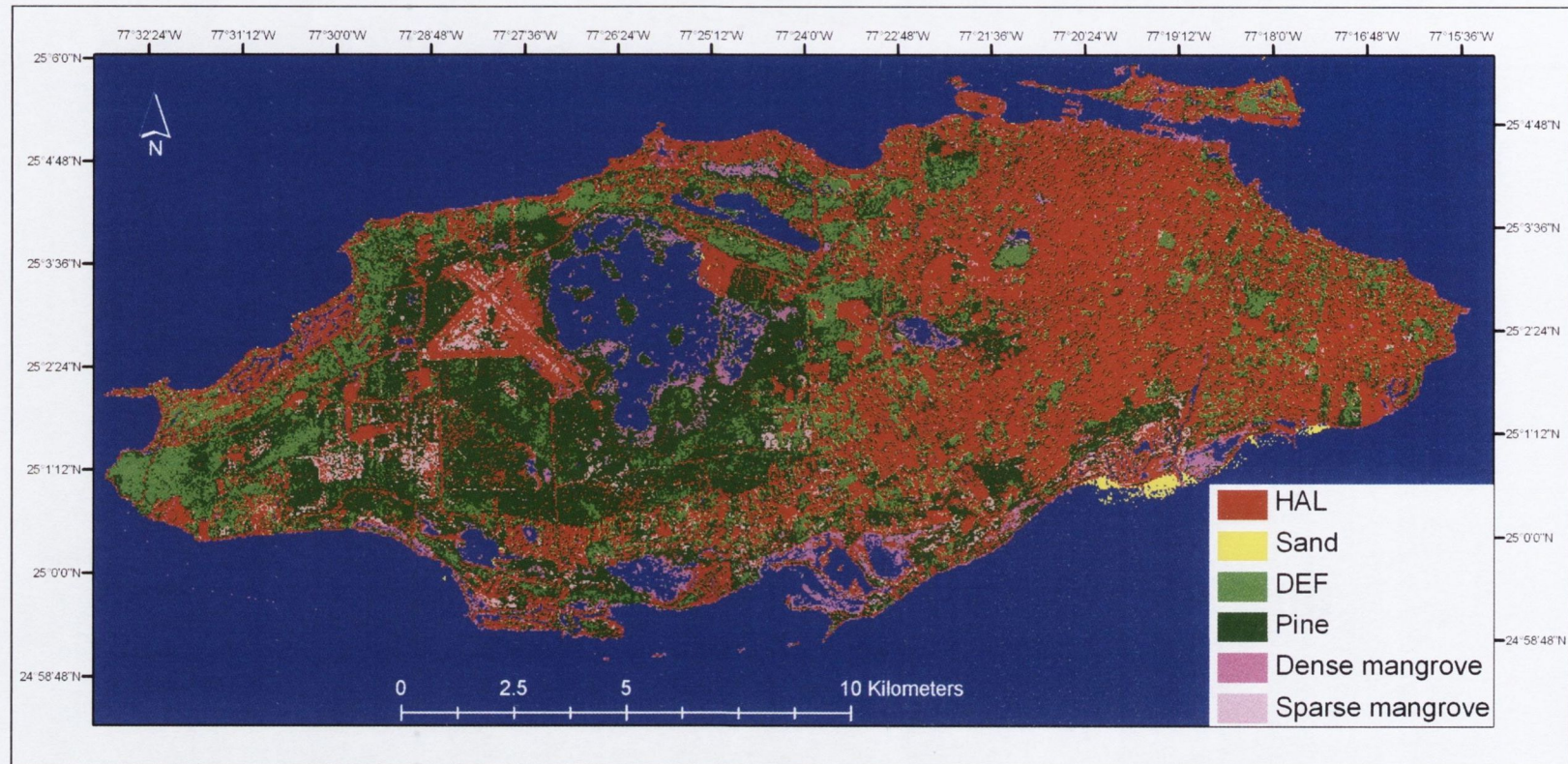
B.27. Landsat ETM+ 2002 PCA (data fusion) land cover classification.



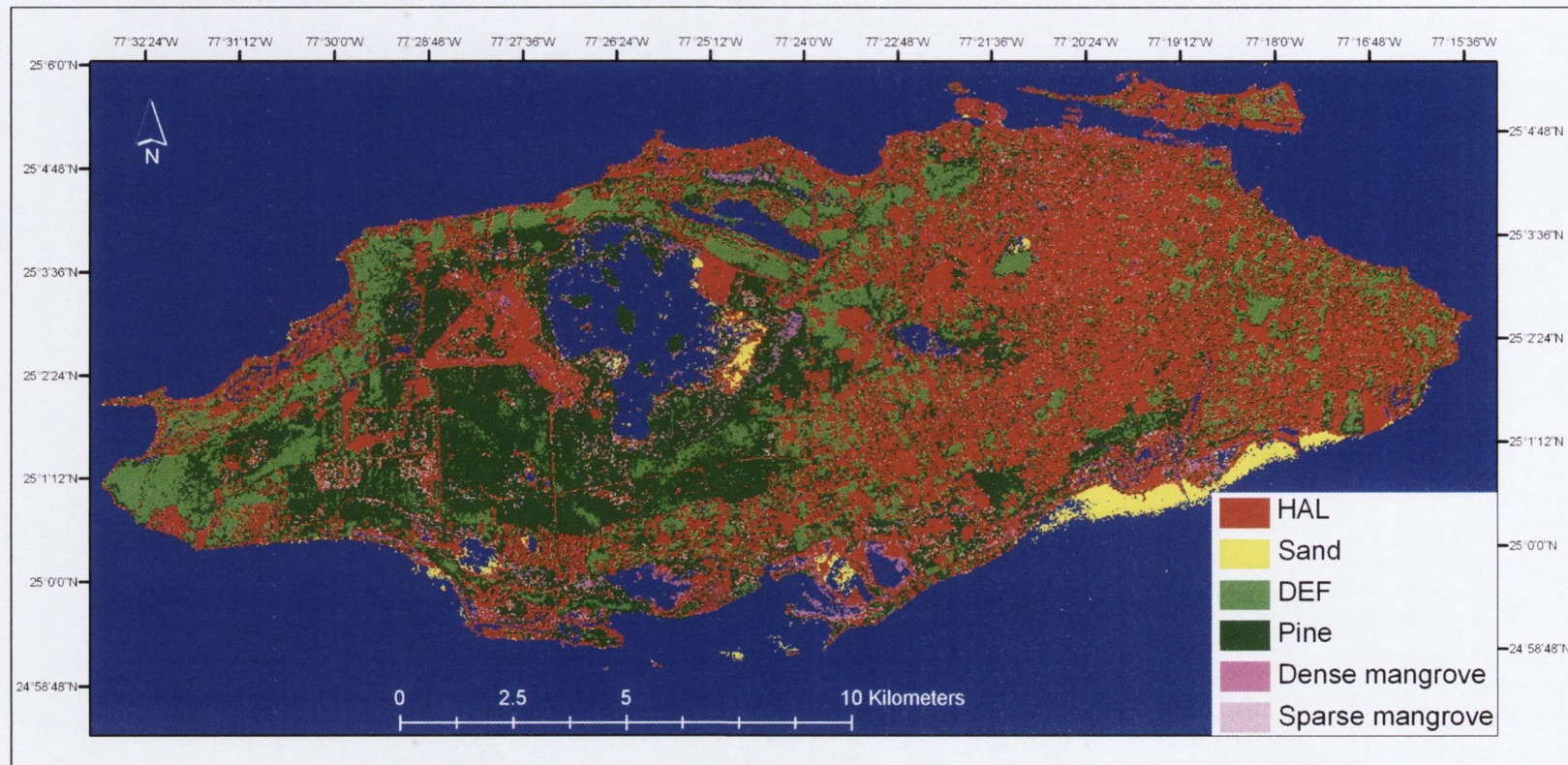
B.28. Landsat ETM+ 2002 Brovey land cover classification.



B.29. Landsat ETM+ 2002 Multiplicative land cover classification.



B.30. Landsat ETM+ 2002 Wavelet PCA land cover classification.



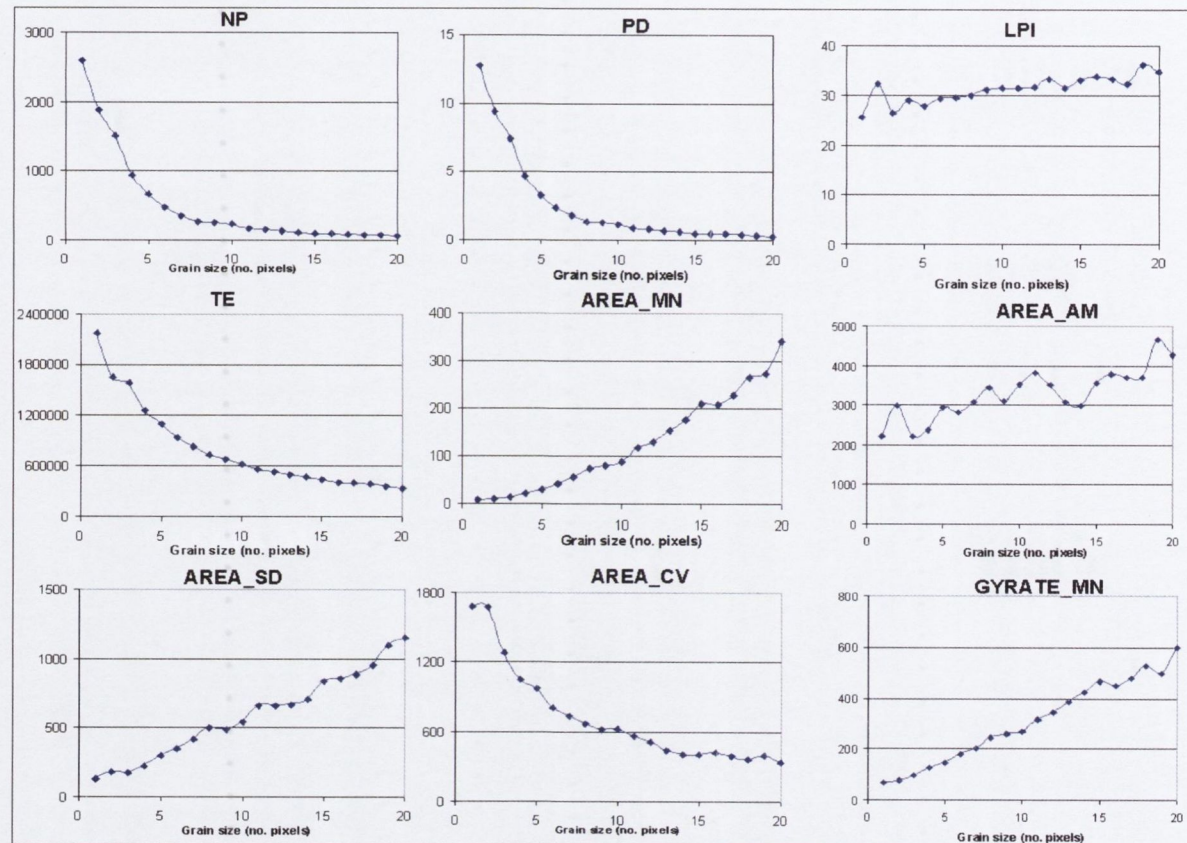
B.31. Landsat ETM+ 2002 Wavelet IHS land cover classification.

Appendix C

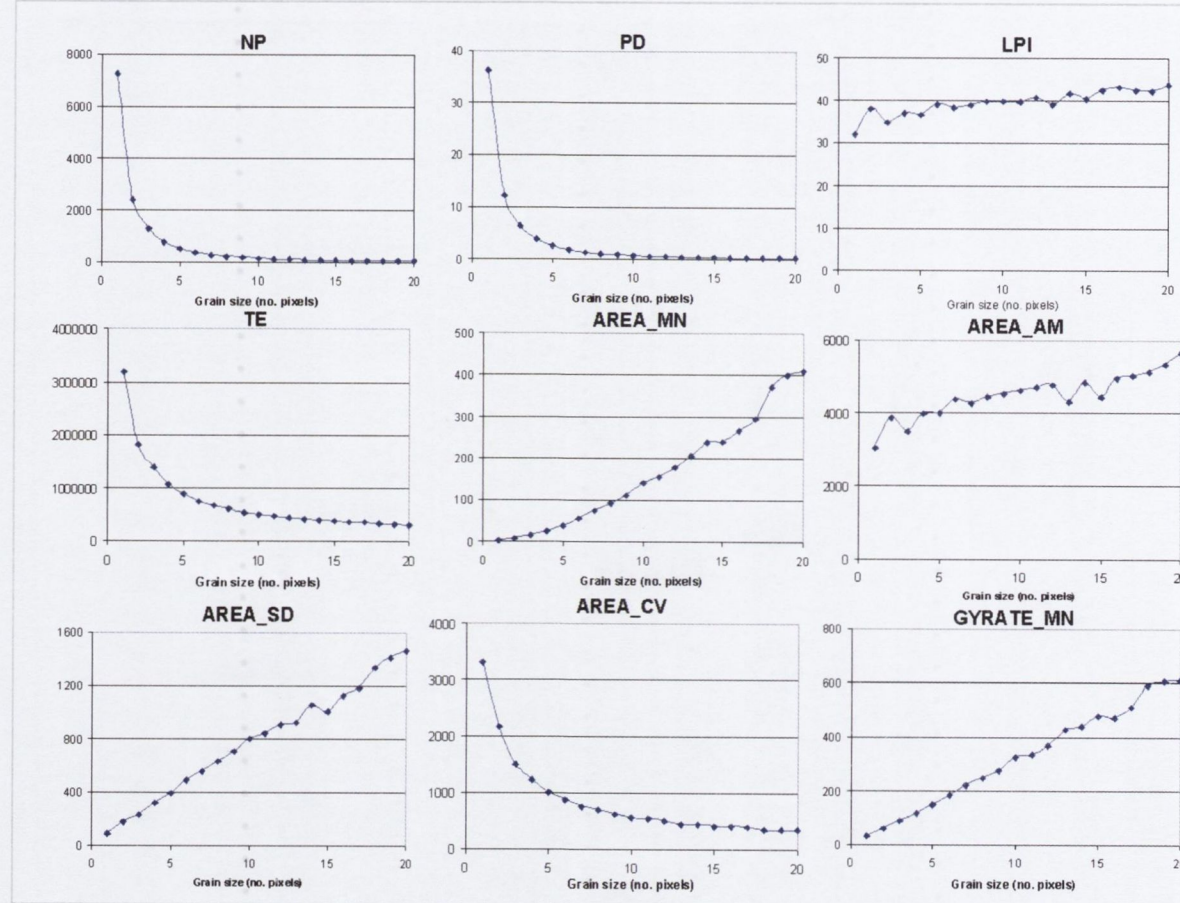
Response curves of spatial metrics generated from the 1973, 1986, 1999 and 2002 land cover maps

C.1. Introduction

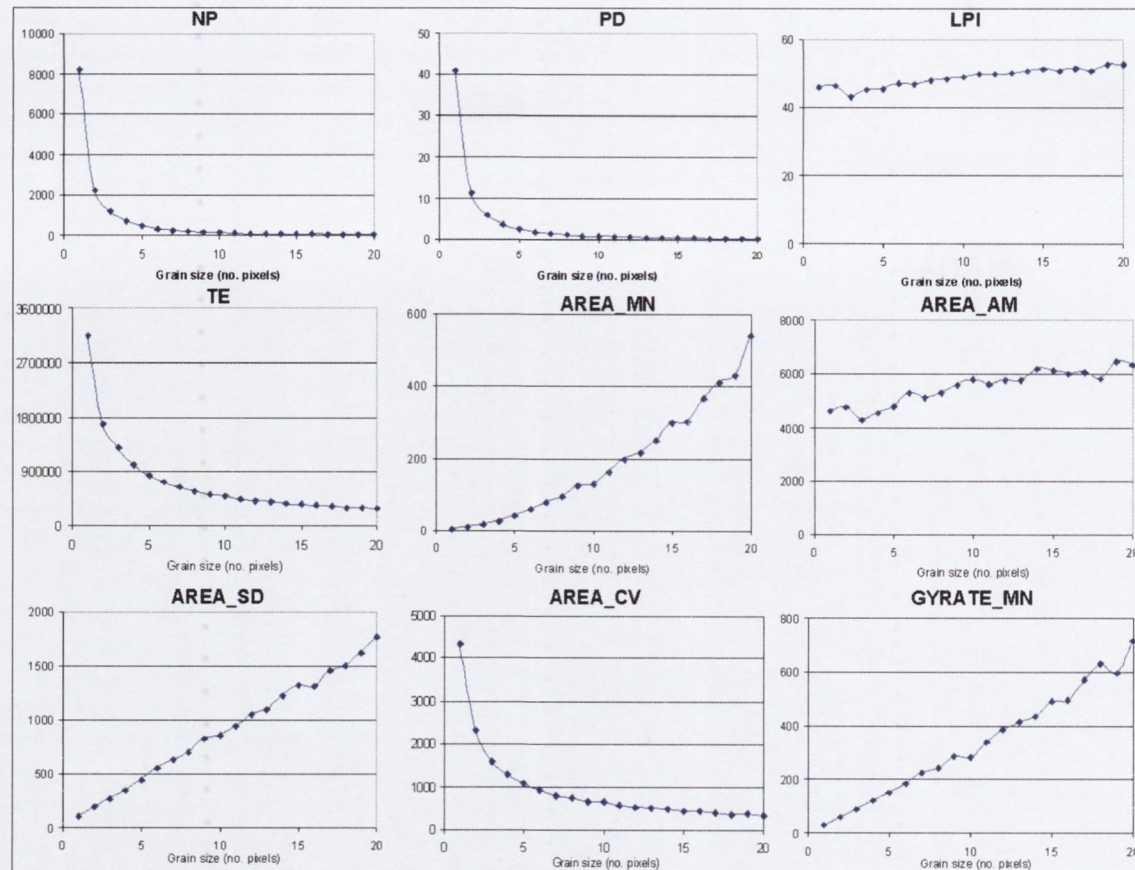
The response of spatial metric values to changing grain size (1x1 pixel to 20x20 pixels) was examined for each map year in the time series. Response curves relating to metric generated for each map year are presented in C.2 through C.13.



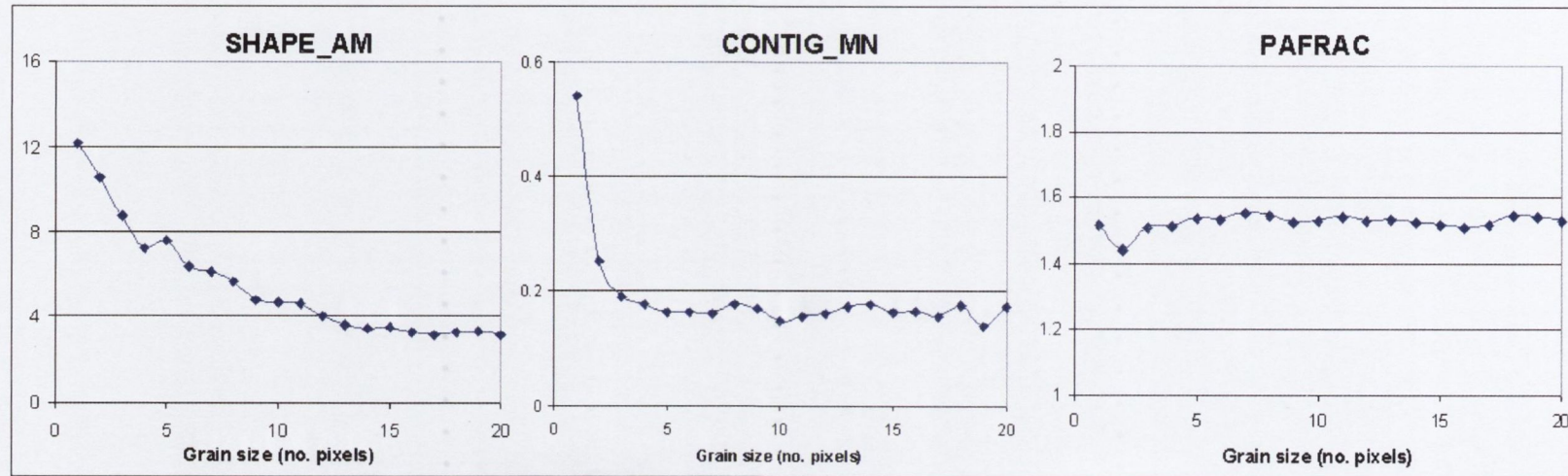
C.2. Response curves of AREA spatial metrics, 1973.



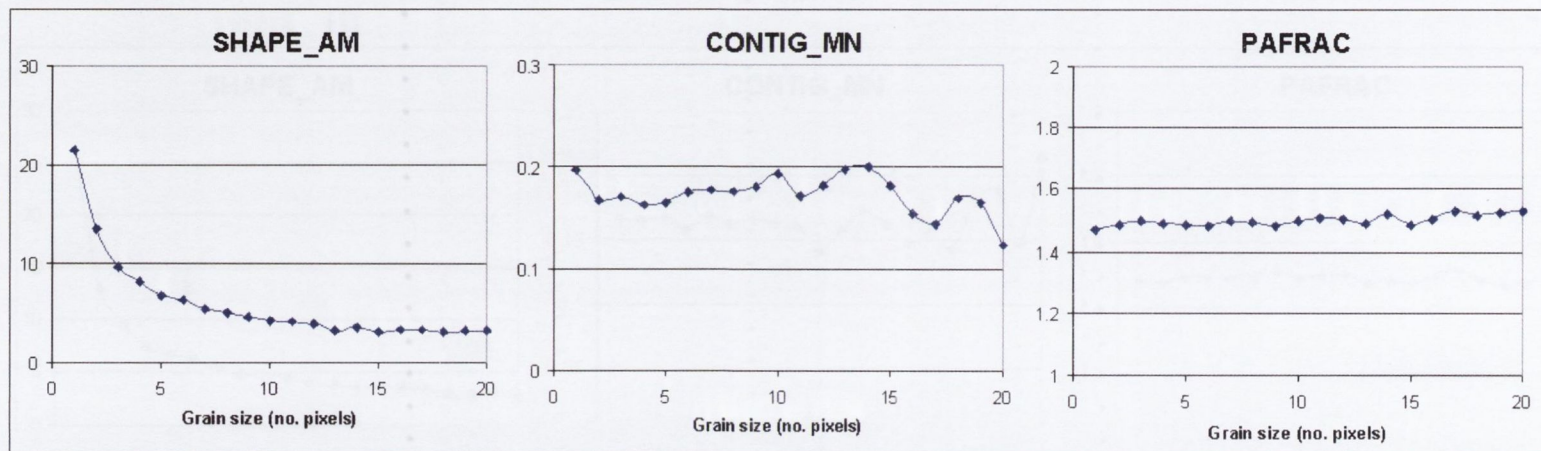
C.3. Response curves of AREA spatial metrics, 1986.



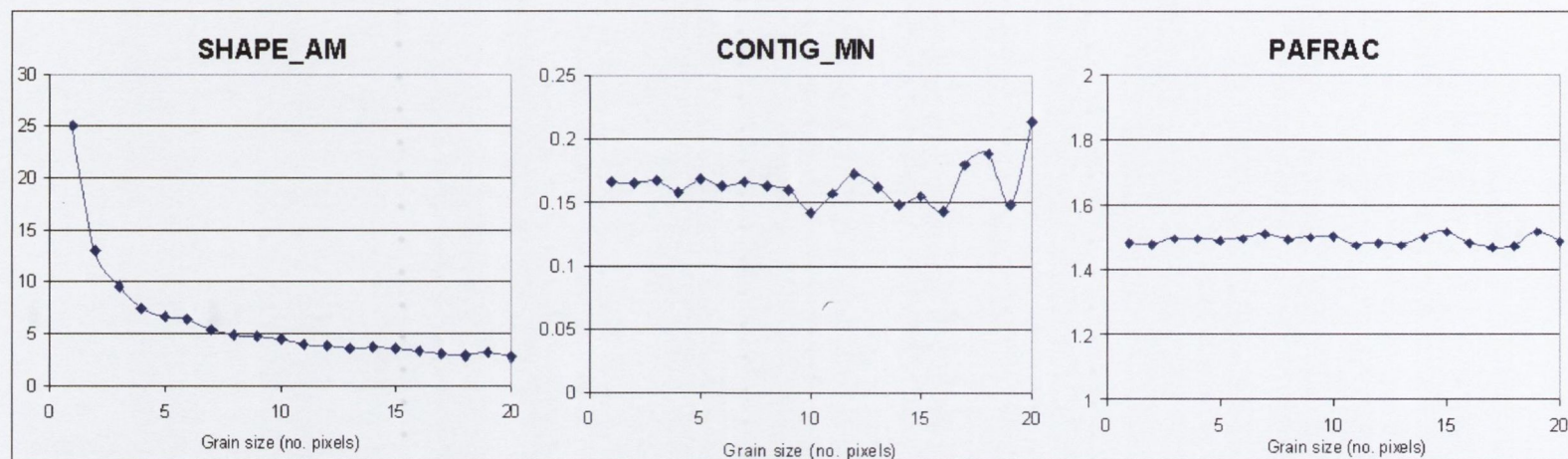
C.4. Response curves of AREA spatial metrics, 1999.



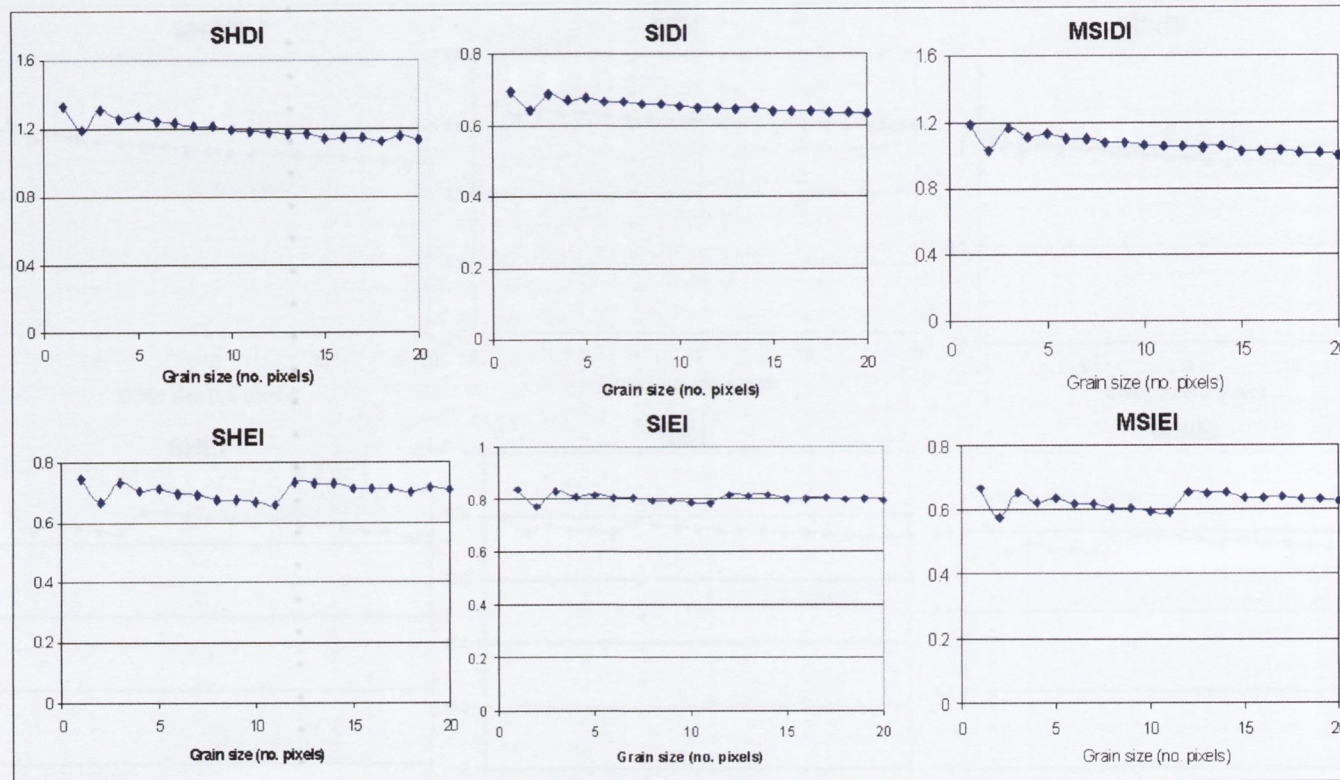
C.5. Response curves of SHAPE spatial metrics, 1973.



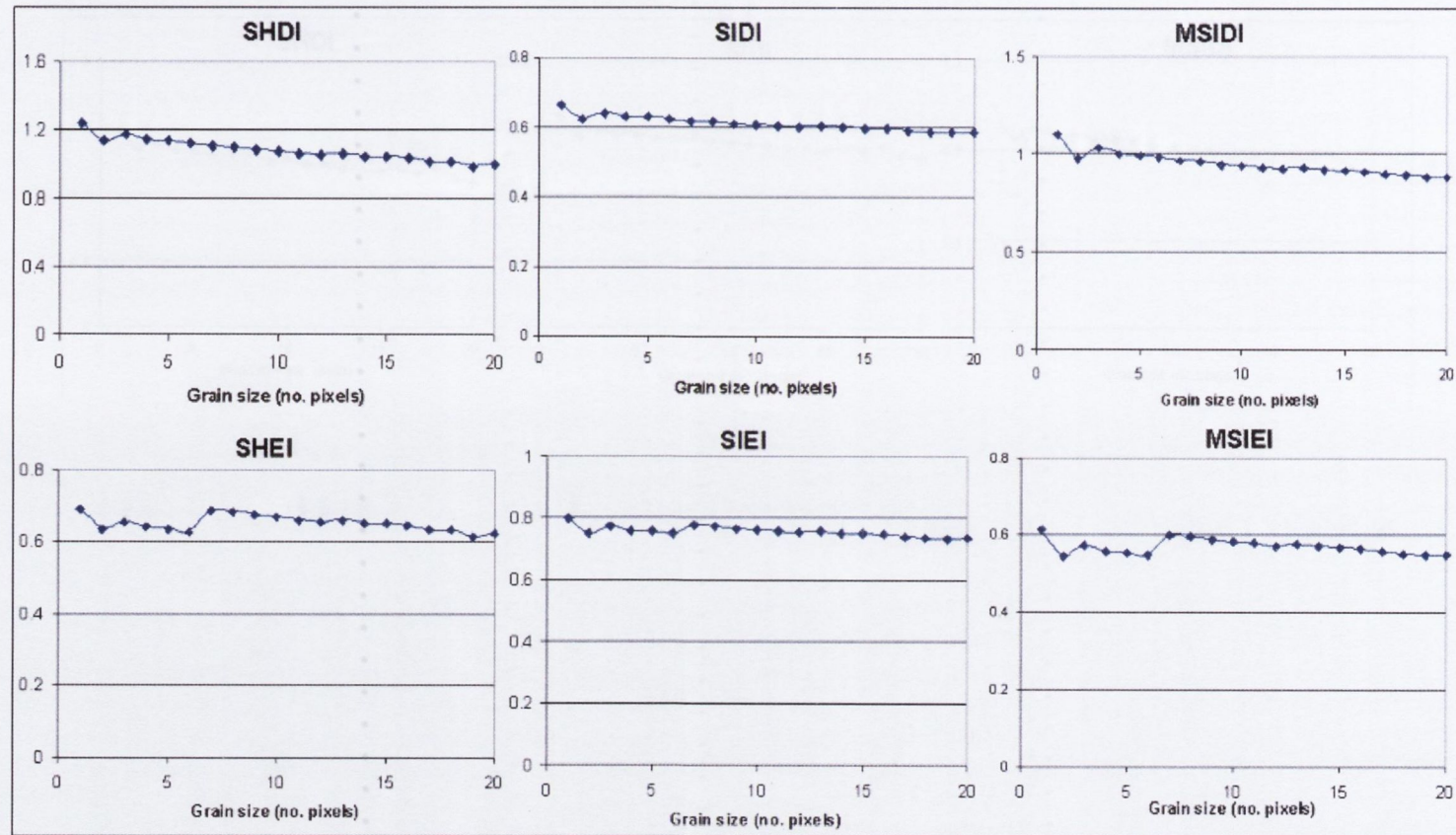
C.6. Response curves of SHAPE spatial metrics, 1986.



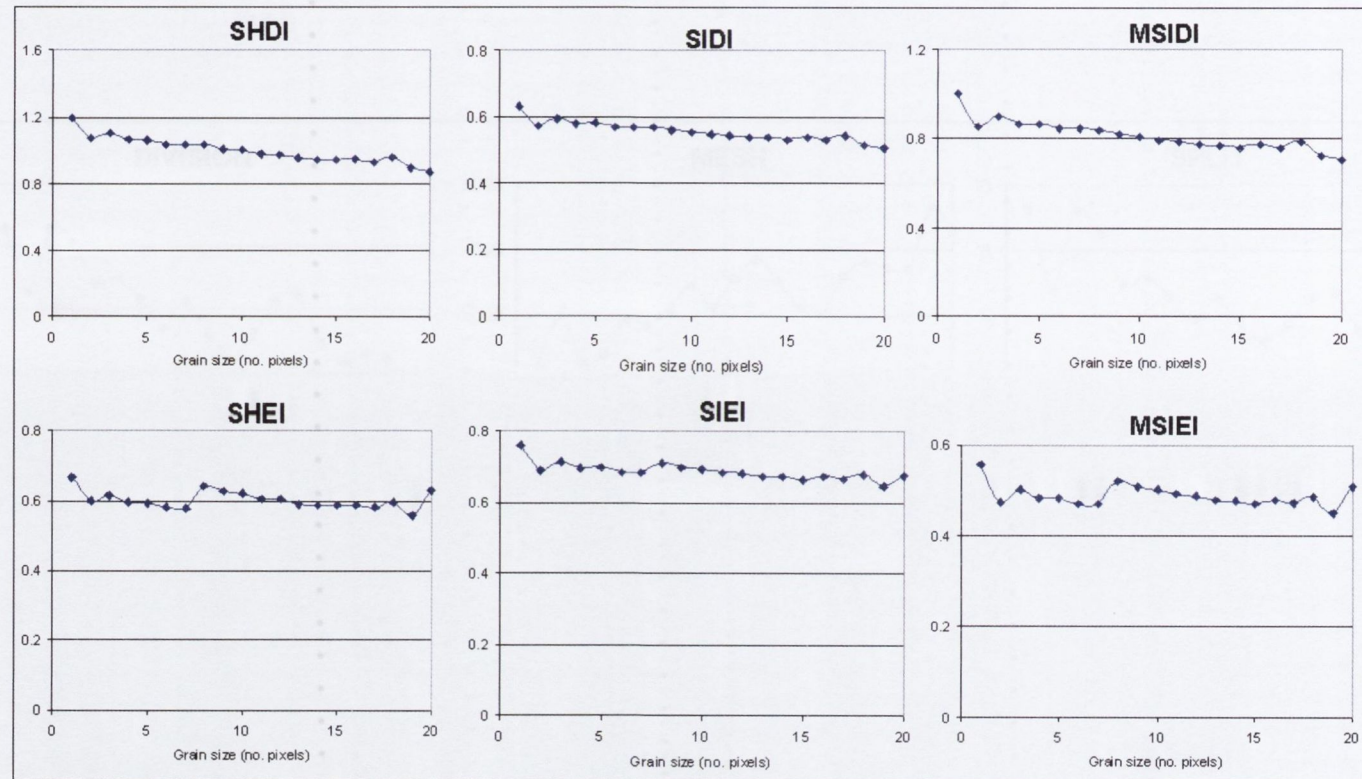
C.7. Response curves of SHAPE spatial metrics, 1999.



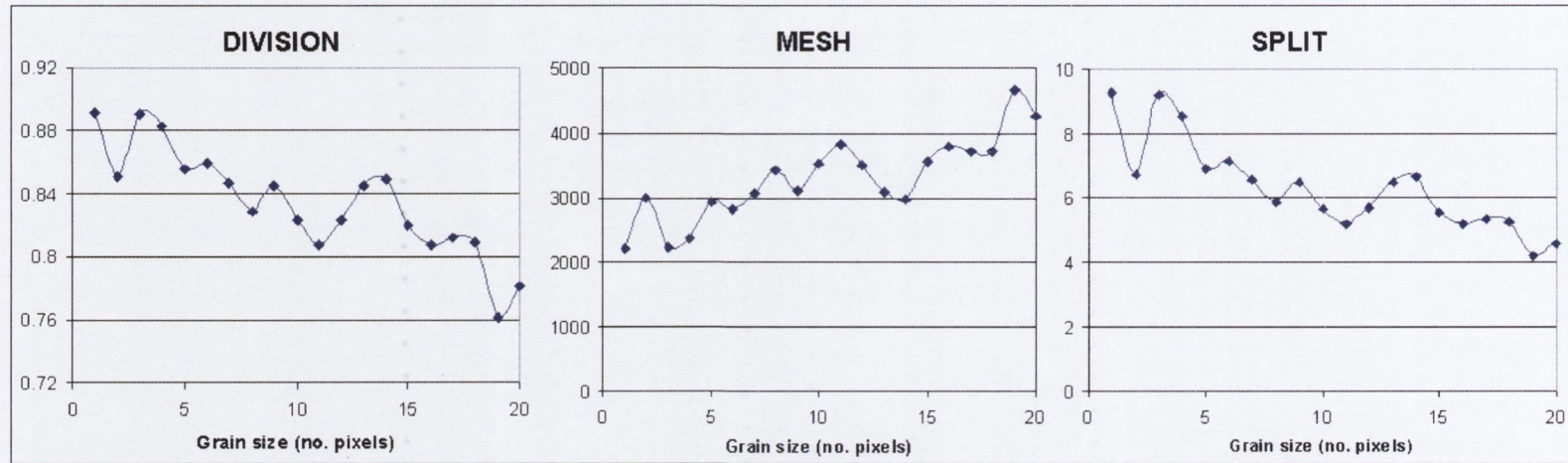
C.8. Response curves of DIVERSITY spatial metrics, 1973.



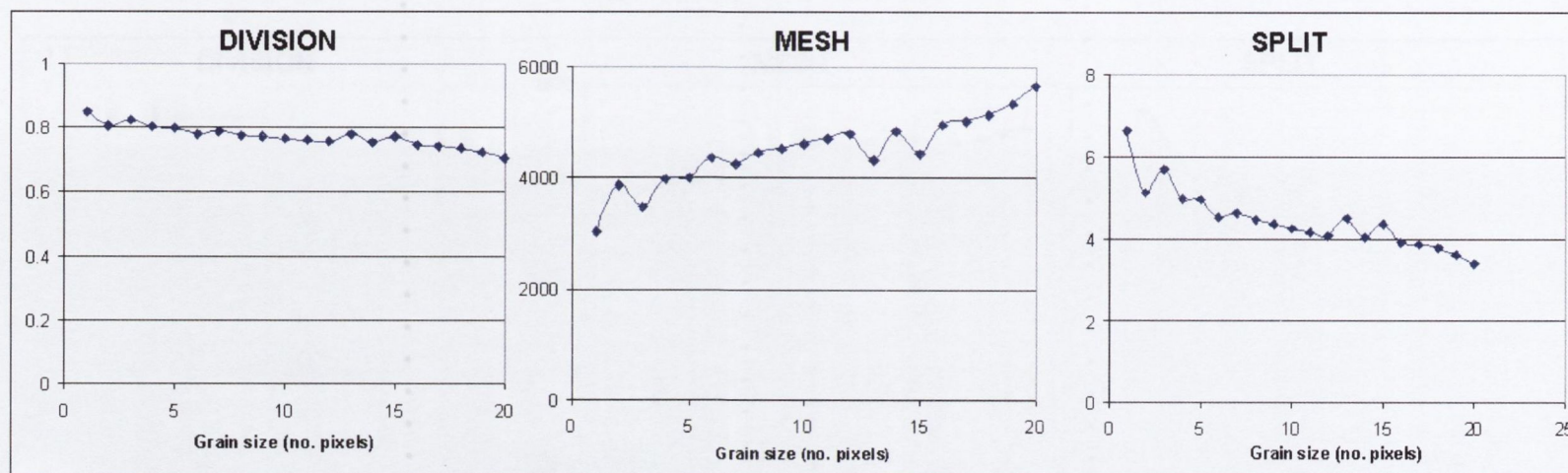
C.9. Response curves of DIVERSITY spatial metrics, 1986.



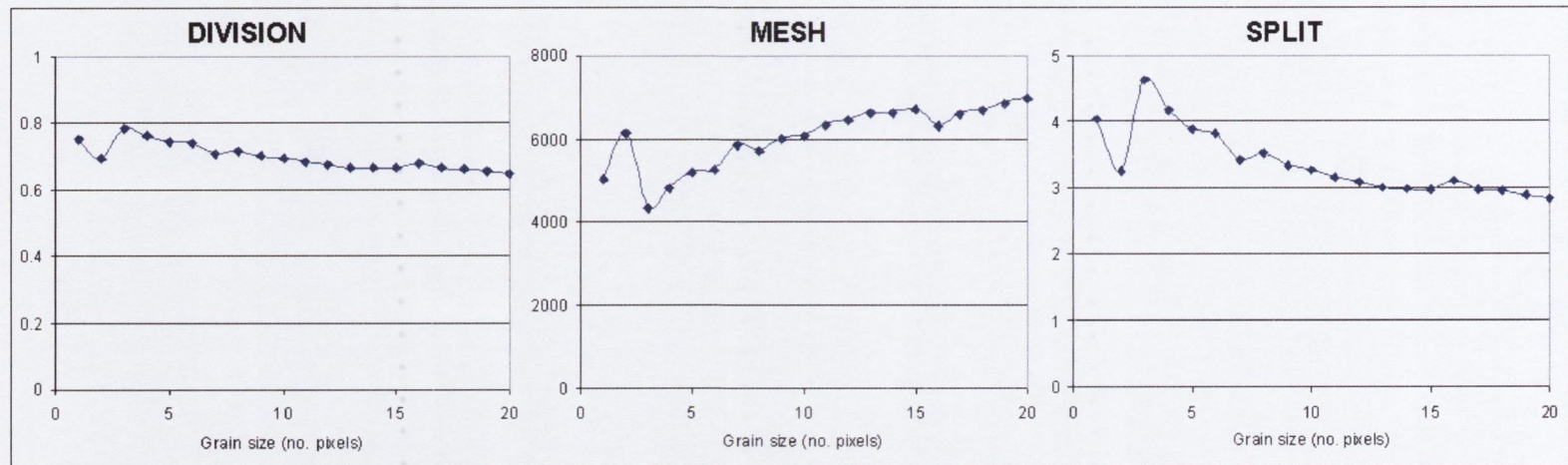
C.10. Response curves of DIVERSITY spatial metrics, 1999.



C.11. Response curves of CONFIGURATION spatial metrics, 1973.



C.12. Response curves of CONFIGURATION spatial metrics, 1986.



C.13. Response curves of CONFIGURATION spatial metrics, 1999.