# HANDBOOK for detecting land cover changes with Landsat data archive

Jan 2011

Northwest Pacific Region Environmental Cooperation Center

# Table of Contents

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1. Introduction ••••••••••••••••••••••••••••••••••••	1
2. Obtaining Landsat data • • • • • • • • • • • • • • • • • •	<b>2</b>
2.1 Websites providing free Landsat data • • • • • • • • • • • • • • • • • •	<b>2</b>
2.2 How to search Landsat data · · · · · · · · · · · · · · · · · ·	3
2.3 How to download Landsat data • • • • • • • • • • • • • • • • • •	12
3. Obtaining data analysis software • • • • • • • • • • • • • • • • • • •	14
3.1 How to obtain data analysis software • • • • • • • • • • • • • • • • • • •	14
3.2 System requirements for data analysis software • • • • • • • • • • • • • • • •	14
3.3 How to install data analysis software • • • • • • • • • • • • • • • • • • •	14
4. Example of data analysis • • • • • • • • • • • • • • • • • •	16
4.1 What to analyze • • • • • • • • • • • • • • • • • • •	16
4.2 Procedures of data analysis • • • • • • • • • • • • • • • • • •	17
4.2.1 Activating MultiSpec · · · · · · · · · · · · · · · · · · ·	17
4.2.2 Importing Landsat data	18
4.2.3 Creating color images of Landsat data · · · · · · · · · · · · · · · · · ·	21
4.2.4 Supervised classification • • • • • • • • • • • • • • • • • • •	28
4.2.5 Clipping the region of interest (ROI) • • • • • • • • • • • • • • • • • • •	36
4.2.6 Statistical processing after supervised classification • • • • • • • • • • • • • • • • • • •	39
5. Reference • • • • • • • • • • • • • • • • • • •	45

#### 1. Introduction

This HANDBOOK for detecting land cover changes with LANDSAT data archive (hereinafter reffered to as "the handbook") introduces procedures of detecting land cover changes with Landsat satellite imagery. Examples in Toyama Bay will be introduced in the handbook.

United States Geological Survey (USGS) announced on April 21, 2008 that they would provide all LANDSAT data archivefor free, and it is possible to download any data for free from several websites including USGS.

There are many softwares for remote sensing data analysis that work under different operating systems.

MultiSpec is the most commonly used software and it is a free software. There are no specific restrictions for its public use, and there are Windows and Macintosh version available.

In the following chapters, how to use MultiSpec for LANDSAT data analysis is introduced with examples.

# 2. Obtaining Landsat data

2.1 Websites for satellite data

Websites to download free LANDSAT dataare shown in table 2.1-1.

table 2.1-1 List of websites to download free LANDSAT data

Websites	Data Providing Organization	URL
Global Visualization Viewer	$\mathrm{USGS}^{*1}$	http://glovis.usgs.gov/
EarthExplorer	USGS	http://edcsns17.cr.usgs.gov/EarthExplorer/
New EarthExplorer	USGS	http://edcsns17.cr.usgs.gov/NewEarthExplorer/
Earth Science Data Interface	$\mathrm{UMD}^{*2}$	http://glcfapp.glcf.umd.edu:8080/esdi/index.jsp
Satellite Image Data Base(SIDaB)	MAFFIN*3	http://rms1.agsearch.agropedia.affrc.go.jp/sidab/index-ja.html

\*1 USGS: United States Geological Survey

 $^{\ast_2}$  UMD: University of Maryland

 $^{\ast 3}$  MAFFIN : Ministry of Agriculture Forestry and Fisheries Research Network

For image search for Toyama Bay area for 1972-2010 by websites above, the following results are shown (Chart 2.1-2). Since both Global Visualization Viewer and EarthExplorer provide the most data, this handbook will use EarthExplorer in the following chapter.

Table 2.1-2 Number of available LANDSAT images to cover Toyama Bay area in 1972-2010. Images with less than 50 % of cloud cover were searched.

Sensor name Websites	MSS WRS-1 path/row : 117/35	TM	ETM+ SLC-on S-2
		path/row	: 109/35
Global Visualization Viewer	11	2	27
EarthExplorer	11	2	27
New EarthExplorer	1	1	1
Earth Science Data Interface	-	3	3
Satellite Image Data Base(SIDaB)	-	3	3

# 2.2 How to search Landsat data

#### 2.2.1. User registration

It is required to complete user registration to download Landsat data for free from USGS website. User registration is not necessary for image browsing. Steps for user registration are as follows:

(1) Open the USGS website (<u>http://edcsns17.cr.usgs.gov/EarthExplorer/</u>) and click "Register" (See the image below).

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アドレス(D)       Http://edcsns17.cr.usgs.gov/EarthExplorer/	🔽 🛃 移動 🖓 変換 🔹 🔂 選択
Science for a changing world	USGS Home Contact USGS Search USGS
EarthExplorer	
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There are 2 messages. (Updated: 1/12/2	010)
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1. Select your dataset(s) Click on  merce next to the category name to show a	2. Enter your search criteria     3. Search >>>       Address/Place     County
	Name/ Zip Code Search: (US/World Feature Search)
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(2) Enter your e-mail address and password.

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Register: Login Info	
The USGS registration service allows you to register and save information that can be used baccess a specific USGS site or to place orders for USGS products. Additional features, such as the ability to save search information, may also be available to registered users depending on the site accessed ( <u>list of sites and features</u> ).	
To register, please create a user name and password. The information you provide will be secure and not shared with others. Review our <u>privacy policy</u> .	
Login information	
User Name: You may wish to use your email address for your user name.	
Password: Username and Password must be at	
Confirm Password:	
Secret Pick A Secret Question Secret Answer: Question: You will be asked for the answer to your secret question if you forget your password.	/
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Accessibility FOIA Privacy Policies and Notices	
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User name---Enter your e-mail address Password --- Create password Password Confirmation ---Enter the same pass word Secret Question---Select a secret question to retrieve the password when forgotten Secret Answer --- Enter the answer for your secret question

After filling in all sections, click "Submit and continue".

(3) Enter your personal information.



When "Thank you, you have successfully registered!" is shown on the screen, user registration is completed.

2.2.2. Searching for Landsat data

Landsat data search takes the following steps:

- > Open the USGS website (<u>http://edcsns17.cr.usgs.gov/EarthExplorer/</u>),
- Login as with your username and password Follow the following 1 to 3 sequences.
   1.Select your dataset(s) > 2.Enter your search criteria > 3.Search>>>
- (1) In the "<u>1. Select your dataset(s)</u>" section, a list of satellite data is shown (See No. 1 in the image below).
- (2) Click "+" in LANDSAT Archive, then more detailed classifications are shown (No. 2).
- (3) Check the box of the sensor you want to search for (No. 3).(You can choose more than 2 at a time.)
- (4) Selected datasets are shown at the bottom (No. 4).

(5) If you want to set more details, such as cloud cover and paths and  $rows(\overset{\gamma}{}_{\mathcal{A}} \square \dot{\mathcal{D}})$ , click "Additional Search Criteria Dataset..."(No 5).

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	1. Select your dataset(s) 2. Enter your search criteria 3. Search	>>>	
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- (6) Move to the "2. Enter your search criteria" section (No. 6 in the image below).
- (7) Enter the search period (No. 7).
- (8) Left-click on the map to decide the search area. Then  $\forall$  is shown after the click (No. 8).
- (9) If you canset the latitude and the longitude of the searching are, set them in the "<u>Area</u> <u>Selected</u>" section (No. 9).
- (10) Choose the number of results you can to see in the "<u>Number of Results</u>" section.
  ("10" is chosen in default configuration. If you select larger number, more scenes are shown.) (No. 10)
- (11) Click "<u>**3.Search>>>**</u>" to start the search (No. 11).



#### 2.2.3. Displaying search results

- (1) After the search is completed, "Complete" is displayed in "<u>Status</u>" of "<u>Result Summary</u>" (No. 1 and 2 in the image below)
- (2) Check the box of "<u>Select</u>" and click on "L7 SLC-on (1999-2003)" in "<u>Data Set</u>" to display the results.



(3) A list of the search results is shown (No. 3).



#### 2.2.4. Ordering data

(1) When "download" is displayed in the "Download" section, you don't have to take additional steps for download: Just click on each "download" (No. 1 in the image below).When "Available by ordering" is shown, follow the next steps.

(2) Check the box in "Order" (No. 2).



(3) Click "Add Selected Items to Shopping Basket" (No. 3).



(4) Then, "1" is shown in the box of "Qty" (No. 4).



(5) Click "<u>View Shopping Basket</u>" (No. 5).



(6) Click "<u>Checkout--></u>" (No. 6).

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(7) Confirm that "Item Total" shows "\$0.00." Then, click "Continue-->" (No. 7).



(8) Check the order item, and click "Submit Order->" (No. 8).

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(9) When your order is properly placed, the message below is shown.



(10) An e-mail for order confirmation is sent to your registered address.



(12) Then, an e-mail for informing availability of download is sent to you. Time to receive this e-mail depends on size of data you ordered.



# 2.3 How to download Landsat data

(1) When you receive the informing e-mail for download availability, click the URL in the e-mail:

http://edcsns17.cr.usgs.gov/cgi-bin/EarthExplorer/run-phtml/results/download.phtml?node=E <u>E&ordered=</u> (See No. I in the image).



(2) Enter your registered "User Name" and "Password." Then, click "Sigh In -->."

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* Please Note: Once you sign in, you may be asked a subset of questions if they were left blank in your registration profile.
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(3) Click "Start Download" in the next page.



(4) For saving the file, click "Save" to start download.



- 3. Obtaining data analysis software
- 3.1 How to obtain data analysis software (MultiSpec)

This handbook provides guidance on analyzing Landsat imagery for detecting land cover changes with MultiSpec, a free software developed in Purdue University (U.S.A.).Multispec is compatible with different forms of data and capable of exporting results with thematic maps and charts for other systems.

Its functions are supervised/non-supervised classification, major element analysis, statistical calculation, feature extraction and selection, thematic map development, with multispectral images.

MultiSpec is available on the website (<u>http://dynamo.ecn.purdue.edu/~biehl/MultiSpec/</u>). Latest information on revision and/or necessary documentation for MultiSpec is also available on the same website.

- 3.2 System requirements for MultiSpec:
  - 1) CPU: Pentium II or above
  - 2) OS: Windows2000/XP/Vista, Macintosh PowerPC/OSX10.3 version or later
  - 3) RAM: over 256 Mbyte (recommended)
- 3.3 How to install MultiSpec (Windows version)
- (1) Double clcik "MultiSpecWin32z.exe" downloaded through the procedures introduced above.
- (2) When the window in Chart 3.3-1 is opened, click "<u>Browse</u>" to find where to install. When the name of the folder is shown under "<u>Unzip to folder</u>", click "<u>Unzip</u>" (Chart 3.3-1 selects "C:¥MultiSpec.")

WinZip Self-Extractor - MultiSpecWin3	2z.exe 🛛 🔀
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Unzip to folder: C:¥MultiSpec Browse	<u>Q</u> lose
☑verwrite files without prompting	About
	Help

Chart 3.3-1 Installing MultiSpec

(3) In the selected folder, "MultiSpecWin32" is created with program files as shown in Chart 3.3-2.

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Chart 3.3-2 Program files created by installing MuitiSpec

(4) Double click "MultiSpecW32.exe", then MultiSpec starts active (Chart 3.3-3).

![](_page_16_Picture_4.jpeg)

Chart 3.3-3 Starting of MultiSpec

#### 4. Eample of data analysis

#### 4.1 Flow of analysis

In this chapter, an flow of Landsat data analysis is introduced. The theme is "Land Cover Classification Analysis in Toyama Bay area." Chart 4.1-1 shows the flow of the procedures.

![](_page_17_Figure_3.jpeg)

Chart 4.1-1 Procedures of Landsat data analysis

Chart 4.1-1 and 4.1-2 are Landsat data of Toyama Bay area including Nanao Bay obtained following the steps explained in Chapter 2.

Satellite	Sensor	Observed date	Path	Row	Scene ID	Resolution
LANDSAT-1	MSS	1973/5/27	117	34	LM11170341973147AAA02	80m
LANDSAT-7	ETM+	2001/5/17	109	34	LE71090342001137EDC00	30m

Chart 4.1-1 LANDSAT data around Nanao Bay area

Satellite	Sensor	Observed date	date Path Row		Scene ID	Resolution
LANDSAT-1	MSS	1972/10/5	117	34	LM11170341972279AAA03	80m
LANDSAT-7	ETM+	2000/10/5	109	34	LE71090342000279EDC00	30m

Chart 4.1-2 LANDSAT data around Toyama Bay area

- 4.2 Procedures of data analysis
- 4.2.1 Activating MultiSpec

(1) Double click "MultiSpecW32.exe" to activate MultiSpec (Chart 4.2.1-1).

![](_page_18_Picture_3.jpeg)

Chart 4.2.1-1. MultiSpec software

(2) The image of MultiSpec activation is shown in Chart 4.2.1-2.

![](_page_18_Picture_6.jpeg)

Chart 4.2.1-2 Activating MultiSpec

There are several menus of MultiSpec:

- File Menu: to open Image File or Project File, to printout, and to save in the disk file
- Edit Menu: to edit (cut, copy, paste, delete, etc.)
- View Menu: to open/close the toolbar and the status bar
  - (Both bars are open in Chart 4.2.1-2.)
- Project Menu: to use for starting a new Project File

"Project File" can memorize the processing procedures, save interim results of image analysis and class statistics, and stop analysis results. This file can re-analyze results later.

- Processor Menu: to use to select MultiSpec processor
- Options (Palette Menu): to use for pre-requisite processing
- Window Menu: to use for creating a new text and/or for selecting display format of a text window.

# 4.2.2 importing LANDSAT data

**LANDSAT-7/ETM+** and **LANDSAT-2/MSS** downloaded following the steps explained in the previous section have information in TIF format by respective band.

# 1. LANDSAT-7/ETM+ taken on May 17, 2001

- L71109034\_03420010517\_B10.TIF : BAND 1 (Resolution 30m)
- L71109034\_03420010517\_B20.TIF : BAND 2 (Resolution 30m)
- L71109034\_03420010517\_B30.TIF : BAND 3 (Resolution 30m)
- L71109034\_03420010517\_B40.TIF : BAND 4 (Resolution 30m)
- L71109034\_03420010517\_B50.TIF : BAND 5 (Resolution 30m)

(Note: BAND 6-8 are not used for supervised classification.)

# 2. LANDSAT-2/MSS taken on May 27, 1973

- LM1117034007314710\_B4.TIF : BAND 4 (Resolution 80m)
- LM1117034007314710\_B5.TIF : BAND 5 (Resolution 80m)
- LM1117034007314710\_B6.TIF : BAND 6 (Resolution 80m)
- LM1117034007314710\_B7.TIF : BAND 7 (Resolution 80m)

For importing LANDSAT-7/ETM+, follow the next steps. You can take the same steps for importing LANDSAT-2/MS as well, although the file name and the number of bands and their combination are different.

(1) Select "<u>Open Image</u>" from "File Menu" and click (Chart 4.2.2-1).

![](_page_19_Picture_16.jpeg)

Chart 4.2.2-1 Displaying images

(2) When options are displayed, select "L71109034\_03420010517\_B10.TIF" and click "<u>Open</u>" (Chart 4.2.2-2).

ファイルを開く						? 🛛
ファイルの場所型:	🗀 data1		1	• 🗧 🔁		
長近使ったファイル	L71109034_0342	20010517_B10.TIF 20010517_B20.TIF				
デスクトップ	T1109034_0342 L71109034_0342 L71109034_0342	20010517_B30.TIF 20010517_B40.TIF 20010517_B50.TIF				
71 I)/L1-9						
マイ ネットワーク	ファイル名(N):	L71109034_034200	010517_B10.TIF		•	開(( <u>0</u> )
	ファイルの種類(工):	Multispectral (*.la 「 読み取り専用フ:	n:*.img:*.bil:*.tif:* ァイルとして開く( <u>R</u> )	hdf;*jp2;*png)	•	キャンセル
Open image as: defa	ult	•				
Select Image.						

Chart 4.2.2-2 Selecting a file

(3) Chart 4.2.2-3 shows how to set display specifications: size of an image file, number of synthesized images, and/or format, etc. Be careful with the values to enter, otherwise you cannot open images properly. When using the TIF File, you do not have to set anything in this page, just click "<u>OK.</u>"

Parameters in Display Specifications:

Area to Display: To set a displayed area of an image

Display: To select display color channel.

There are 4 types: 3-Channel Color; 2-Channel Color, 1-Channel Color and Side by Side Channel (Black and white color for each band) Magnification: To set a scale of an image

Enhancement: To set enhancement of an image

Set Display Specifications for:	
L71109034_03420010517_B10.TIF Area to Display	
Line Start End Inter	rval
Column 1  8061  1	
Display	Enhancement
Type: 1-Channel Grayscale 💌	Bits of color: 8
Channels:	Stretch:
Grey 🗖 Invert	Min-max: Clip 2% of Tails
,	Treat '0' as: Data 💌
	Number of display levels: 254
Ob served Discontinuity	🔽 Load New Histogram
unannel D'escriptions	
Magnification: 0.1111111	
	Cancel OK

Chart 4.2.2-3 Setting Display Specifications

(4) Chart 4.2.2-4 shows how to set histogram specifications. Just click "OK", unless you need to change values.

Set Histogram Specifications
Image file: L71109034_03420010517_B10.TIF
Default Statistics File: "None"
Method: Compute new histogram 💌
Area to Histogram
Start End Interval
Column  1  8061  1
Channels: All
List options
✓ List histogram summary
Cancel OK

Chart 4.2.2-4 Setting Histogram Specifications

Parameters in Histogram Specifications:

Method: to set histogram

Compute new histogram: to create a new histogram Select default statistics: to set the default histogram file

(5) After you click "OK" on Histogram Specifications, an image is displayed (Chart 4.3.2-5).

![](_page_21_Picture_7.jpeg)

Chart 4.2.2-5 Example of an image

# 4.2.3 Creating color images of LANDSAT data

As input LANDSAT data has different bands, it is necessary to synthesize these bands to process Land Cover Classification and create color images. Steps for this task are as follows.

![](_page_22_Picture_2.jpeg)

(1) With BAND 1 image on screen, select "Open Image" in "File Menu" and click.

Chart 4.2.3-1 Single-band image

(2) Check "Link to active image window" on the bottom and select "L71109034\_03420010517\_B20.TIF", then click "Open" (Chart 4.2.3-2).

ファイルを開く							? 🛛
ファイルの場所型:	🚞 data1			•	← 🗈 ć	* 💷 *	
ようしています。 最近使ったファイル で入りトップ	L71109034_03420           L71109034_03420           L71109034_03420           L71109034_03420           L71109034_03420           L71109034_03420	0010517_B10.TIF 0010517_B20.TIF 0010517_B30.TIF 0010517_B40.TIF 0010517_B50.TIF					
ک ۱۷۶۶ ۲۶							
ער בארב איז ארבארב איז							
マイ ネットワーク	ファイル名(N):	L71109034_03420	010517_B20.TIF			•	開(())
	ファイルの種類(1):	Multispectral (*.la 「読み取り専用フ	an;*.img;*.bil;*.tif ァイルとして開く( <u>F</u>	;*.hdf;*; })	ip2;*png)	•	
Open image as: Multi I⊽ Linit to active imag Select File 2 to Link.	spectral type e window						

Chart 4.2.3-2 Creating a color image -1

(3) Next, select "L71109034\_03420010517\_B30.TIF" and click "<u>Open</u>." Repeat it until L71109034\_03420010517\_B50.TIF (Chart 4.2.3-3).

ファイルを聞く			? 🔀
ファイルの場所①:	🗀 data1		
最近使ったファイル デスクトップ マイ ドキュメント	L71109034_0342 L71109034_0342 L71109034_0342 L71109034_0342 L71109034_0342	20010517_B10.TTF 20010517_B20.TTF 20010517_B30.TTF 20010517_B40.TTF 20010517_B50.TTF	
V1 J2E1-9			
マイ ネットワーク	ファイル名(N):	L71109034_03420010517_B50.TIF	III (Q)
	ファイルの種類(①:	Multispectral (*.lan;*.img;*.bil;*.tif;*.hdf;*jp2;*png)	キャンセル
		□ 読み取り専用ファイルとして聞く(E)	
Open image as: Mult	ispectral type		
🔽 Link to active imag	je window		
Select File 5 to Link.			

Chart 4.2.3-3 Creating a color image-2

(4) Then, click "Cancel" (Chart 4.2.3-4).

ファイルを開く	?	
ファイルの場所型:	🔁 data 💌 🔶 🔁 📅	
していた つうし 400		
7 ( K¥1X)		
₹1 ⊒ンピュータ		
マイ ネットワーク	771ル名心:	
	ファイルの種類(D: Multispectral (*.lan,*.img,*.bil*.tif,*.hdf,*.jp2,*.png) ▼ キャンセル 「読み取り専用ファイルとして閉く(R)	
Open image as: Multi	ispectral type	
🗹 Link to active imag	je window	
Select File 5 to Link.		

Chart 4.2.3-2 Creating a color image-3

(5) Make sure that "L5-L71109034\_03420010517\_B10.TIF" is surely indicated on top. This means that the number of layers is 5 (5 bands- from BAND 1 to BAND 5) (Chart 4.2.3-5).

![](_page_24_Picture_1.jpeg)

Chart 4.2.3-5 Creating a color image-4

(6) Save the multiple-layered image. Click "Processor Menu" and select "<u>Reformat</u>" and then "C<u>hange Image File Format</u>" (Chart 4.2.3-6).

![](_page_24_Picture_4.jpeg)

Chart 4.2.3-6 Saving a color image-1

(7) Just click "OK", unless you need to change values. (Chart 4.2.3-7).

Set Image File Format Change Specifications	s 🛛 🔀
Input file: L71109034_03420010517_B10.TIF Lines: 7091 Channels: 5 Columns: 8061 Data value type: 84	Band format: BSQ bit Unsigned Integer
Area to Reformat Line 7091 1 Column 1 8061 1	Channels: All  Coptions Invert bottom to top Invert right to left Swap Bytes
Data value type: 8-bit Unsigned Integer	Write channel descriptions Header: GeoTIFF format Cancel OK

Chart 4.2.3-7 Saving a color image-2

(8) Set an output file and click "<u>Save</u>". "17\_p109r34\_20010517.tif" is selected in the example (Chart 4.2.3-8).

名前を付けて保存					? 🗙
保存する場所①:	🗀 data1		• +	E 💣 📰	
最近使ったファイル デスクトップ マイドキュメント マイコンピュータ	L71109034_03420 L71109034_03420 L71109034_03420 L71109034_03420 L71109034_03420 L71109034_03420	0010517_B10.sta 0010517_B10.TTF 0010517_B20.TTF 0010517_B30.TTF 0010517_B30.TTF 0010517_B40.TTF			
	 ファイル名( <u>N</u> ):	109r34_20010517.tif		•	保存( <u>S</u> )
	ファイルの種類( <u>T</u> ):	All Files (*.*)		•	キャンセル

Chart 4.2.3-8 Saving a color image-3

(9) Percentage of data processing status is shown until completed. Then, the window disappears automatically when the processing is done (Chart 4.2.3-9).

![](_page_25_Picture_7.jpeg)

Chart 4.2.3-9. Saving a color image-4

(10) When a color image is created, click " $\underline{X}$ " on the right top and close the window (Chart 4.2.3-10).

![](_page_26_Picture_1.jpeg)

Chart 4.2.3-10 Closing the color image window

(11) Select "Open Image" from "File Menu" and click (Chart 4.2.3-11).

![](_page_26_Picture_4.jpeg)

Chart 4.2.3-11

(12) Select the created "17\_p109r34\_20010517.tif" and click "Open" (Chart 4.2.3-12).

ファイルを開く				? 🛛
ファイルの場所①	🗀 data1			
<ul> <li>● しんしょう (1)</li> </ul>	I7_p109734_2001           U71109034_034;           U71109034_034;           U71109034_034;           U71109034_034;           U71109034_034;           U71109034_034;           U71109034_034;           U71109034_034;           U71109034_034;	051741 20010517_B10.TIF 20010517_B20.TIF 20010517_B30.TIF 20010517_B40.TIF 20010517_B50.TIF		
マイ ネットワーカ				
111012	ファイル名(N):	109r34_20010517.tif	<u> </u>	
	ファイルの種類(工):	Multispectral (*.lan;*.img;*.bil	*.tif;*.hdf;*jp2;*png) 💽	
		□ 読み取り専用ファイルとして開	Ҟ( <u>R</u> )	
Open image as: defa	ault	•		
Link to active image	ge window			
Select Image.				

Chart 4.2.3-12 Selecting an image

- (13) Set "<u>Channels</u>": 5 in Red; 4 in Green; and 3 in Blue. Then, click "<u>OK</u>" (Chart 4.2.3-15). This band combination is used to create "Middle-infrared image, and it is suited for classifying land cover into water, agricultural and paddy fields and bare lands. The following band combinations are also available for supervised classification in case of Landsat-7/ETM+.
  - R:G:B = Band 3:Band 2:Band 1 is called "true color" and it shows objects in the same color that human eyes would normally see. This band combination is suited for classifying land cover into water, urban area, agricultural field, golf course and forest.
  - R:G:B = Band 4:Band 3:Band 2 is called "false color" and it enhances vegetation in red. This band combination is suited for classifying land cover into paddy field, agricultural field and forest.

Set Display Specifications for:	
I7_p109r34_20010517.tif Area to Display	
Line 1 7091	1
Display	
Type: 3-Channel Color	Bits of color: 24
Channels:	Stretch: Linear
Red: 5 🗆 🗆 Invert	Min-max: Clip 2% of Tails
Green: 4 🗌 Invert	Treat '0' as: Data
Blue: 3 🗌 Invert	Number of display levels: 256
Channel Descriptions Magnification: 0.1111111	Coad New Histogram
	Cancel

Chart 4.2.3-13 Setting Display Specifications

(14) Do **NOT** set anything in Histogram Specifications, just click "<u>OK</u>" (Chart 4.2.3-14).

Set Histogram Specificati	ons tif							
Image rile: 1/_p103r34_20010517.tr Default Statistics File: "None"								
Method: Compute new histogram	-							
Area to Histogram Start	End	Interval						
Line 1	7091	57						
Column 1	8061	1						
Channels: All								
List options								
List histogram summary								
		Cancel	OK					

Chart 4.2.3-14 Setting Histogram Specifications

(15) Then, a color image is displayed on screen (Chart 4.2.3-15).

![](_page_28_Picture_4.jpeg)

Chart 4.2.3-15 Example of a color image

#### 4.2.4 Supervised classification

In this chapter, the procedures of how to apply supervised classification to the color image created in the previous section are introduced.

(1) Select " <u>Statistics</u> " in "Processor Menu" and click " <u>OK</u> " (Chart 4.2.4	-1)
---	-----

Set Project Options	
Project Commands	Outline selected areas: ✓ Training fields ✓ Test Fields ✓ Show class names ✓ Show field names Show Train/Test Label Color: White ▼
Training mask file: None	•
Test mask file: None	-
	Cancel OK

Chart 4.2.4-1 Statistics

(2) Then, a new window "Select Field" is shown on the right side (Chart 4.2.4-2).

![](_page_29_Picture_6.jpeg)

Chart 4.2.4-2 Setting training areas-1

(3) Set a training area: Make the image "**17\_p109r34\_20010517.tif active**" (click on the screen), then drag the mouse to set an area (Chart 4.2.4-3).

![](_page_30_Picture_1.jpeg)

Chart 4.2.4-3 Setting training areas-2

(4) Click "<u>Add to List</u>" in the "<u>Select Field</u>" window and enter "water" in the "<u>Enter Class Name</u>" section. Then, click "<u>OK</u>" (Chart 4.2.4-4).
 (Net : D. NOT then the "Class" of the section of the section of the section of the section.

(Note: Do **NOT** change the "<u>Class</u>" section and keep "<u>New</u>.")

![](_page_30_Picture_5.jpeg)

Chart 4.2.4-4 Setting training areas-3

(5) The training area (water) is displayed on screen (Chart 4.2.4-5). Set other training areas\* with the same procedures shown in the previous section.

Use the following icons to zoom in-out when setting training areas.

![](_page_31_Picture_2.jpeg)

Chart 4.2.4-5 Setting training areas-4

\*Setting of training areas should be done with grand truth data such as vegetation map and topographic map. This sample uses vegetation map and topographic map provided by Japan Map Center Foundation as references for supervised classification.

(6) Training areas set are as follows (see Chart 4.2.4-1 and Figure 4.2.4-6).

areas and classification
Class Name
water
urban area
paddy field
agricultural field
waste land
golf field
broad leaf forest
Needle leaf forest

Table 4.2.4-1. Training areas and classification

![](_page_32_Picture_0.jpeg)

Chart 4.2.4-6 Setting training areas-5

(7) Update statistic information in each supervised classification by clicking  $\lceil Classes \rfloor$  then  $\lceil Update Project Stats \rfloor$ .

![](_page_33_Figure_1.jpeg)

Char 4.2.4-7 Updating statistic information in each classification area.

(8) Now, click "Classify" in "Processor Menu" to apply supervised classification.

![](_page_33_Picture_4.jpeg)

Chart 4.2.4-8 Supervised Classification

(9) MultiSpec has six algorisms for supervised classification. In this handbook, the most common Maximum Likelihood method for data processing is used.

Check "Desk file" under "Write classification results to" and click "OK" (Chart 4.2.4-8).

Set Classification Specifications			
Procedure: Maximum Likelihood	Classes: All		
Channels: All Available 💽	Symbols: Default set Write classification results to: I Disk file: ERDAS_GIS ▼		
Classify:	🔲 Image Window Overlay		
Class areas: All  Training (resubstitution) Training (leave-one-out) Test areas (holdout)	Palette: Default Colors 💌		
Image selection			
Area to Classify Line 1 7091 1 Column 1 8061 1	Create Probability Results File Results List Options Cancel OK		

Chart 4.2.4-9 Window of statistical data processing-1

(10) In case not updating statistic information in the previous section, the following pop up window is displayed (Chart 4.2.4-10). Then, click "<u>OK</u>."

MultiSp	ec Windows Application 🛛 🛛 🔀
♪	Update project statistics before continuing?
	OK キャンセル

Chart 4.2.4-10 Window of statistical data processing-2

(11) Click "Save" with the default file name (Chart 4.2.4-10).

Save Classificati	on As:				? 🗙
保存する場所型:	🛅 data1		•	← 🗈 📸 📰 -	
して 最近使ったファイル					
<b>ごう</b> デスクトップ					
ک ارلاد#۲ ۲۶					
קי בשעב אד					
🧐 २८ २७-७					
	ファイル名(N):	17_p109r34_20010517.gis		✓ (保有)	7( <u>S</u> )
	ファイルの種類(工):	Thematic (*.gis)		• <b>*</b> *	ven

Chart 4.2.4-11 Saving Output file

(12) The title "Text Output" is changed to "Untitled Project", and classification of images is started (Chart 4.2.4-12).

![](_page_35_Figure_1.jpeg)

Chart 4.2.4-12 Result of text output for supervised classification image

(13) Percentage of data processing status is shown until completed. Then, the pop up window disappears automatically (Chart 4.2.4-13).

Status	
Classifying: Image Area	
Line 2463 of 7091	
Minutes until completion:	0.5
	Strike 'Esc' key to cancel operation

Chart 4.2.4-13 While data processing

 (14) Select the supervised classification file "17\_p109r34\_20010517.gis" (Chart 4.2.4-14). Then, select "<u>Open Image</u>" in "File Menu" and change the File Type (T) to "Thematic" (\*.gis,\*.tif).

ファイルを開く					? 🛛
ファイルの場所型:	🚞 data1		•	🗈 💣 💷	
<ul> <li>最近使ったファイル</li> <li>デスクトップ</li> <li>マイドキュメント</li> <li>マイドキュメント</li> <li>マイコンピュータ</li> </ul>	17         p109x84         2001           167         r_j_j109x44         2001           1         L71109034         0342           1         L71109034         0342	251741: 251741 251741 0010512,810.11F 0010517,820.11F 0010517,830.11F 0010517,860.11F			
२२ २७२७-७	ファイル名( <u>N</u> ): ファイルの種類( <u>T</u> ):	7_p109r34_20010517.gis  Thematic (*.gis:*tif)  「読み取り専用ファイルとして開い	ß	•	開(@) キャンセル
Open image as: defa Select Image.	ult	•			

Chart 4.2.4-14 Displaying images of supervised classification-1

(15) Click "<u>OK</u>" (Chart 4.2.4-15).

I7_p109r34_200 Area to Display	Start         End           10517.gis         7091           1         8061	Interval	Magnification
Palette: ERDAS.trl Display: Classes	file 💌	Number cla Number gro	sses: 9 ups: 0
Background color			
		Cancel	OK

Chart 4.2.4-15 Displaying images of supervised classification-2

(16) An image of supervised classification is displayed. The colors used are the default set.

![](_page_36_Figure_4.jpeg)

Chart 4.2.4-16 Example of supervised classification image

(17) For changing colors, double click the color you want to change. Then, the color palette is shown on screen. Click a new color on the palette, and it is reflected on the image automatically (Chart 4.2.4-17).

![](_page_37_Figure_1.jpeg)

Chart 4.2.4-17 Category change-1

(18) Changed color(s) are reflected in the revised image (Chart 4.2.4-18).

![](_page_37_Picture_4.jpeg)

Chart 4.2.4-18 Category change-2

#### 4.2.5 Clipping the region of interest (ROI)

This chapter introduces the steps of how to clip the region of interest (ROI) in the supervised classification images.

![](_page_38_Figure_2.jpeg)

(1) Select "<u>Change Image format</u>" in "<u>Reformat</u>" from "Process Menu" (Chart 4.2.5-1).

⊠ 4.2.5-1Clipping the Region of Interest(ROI)

(2) Set the image size of ROI. "Line" indicates the vertical position and "Column" indicates the horizontal position for clipping. Chart 4.2.5-2 shows an example for Line : 3291pixel – 5433, and Column : 1396 – 4029. After setting the position, click "<u>OK</u>".

Set Image File Format Change Specifications	:
Input file: 17_p109r34_20010517.gis Lines: 7091 Classes: 9 Columns: 8061 Data value type: 84 Output file: New File 💽	Band format: BSQ bit Unsigned Integer
Area to Reformat           Start         End         Interval           Line         3291         5433         1           Column         1396         4029         1	Options Invert bottom to top Invert right to left
Transform Data	Swap Bytes Write channel descriptions Header: ERDAS 74 format
Data value type: 8-bit Unsigned Integer 🗨 💌	Cancel DK

Chart 4.2.5-2 Setting the clipping position of ROI

(3) Set the output file. Chart 4.2.5-3 selects "**cut\_l7\_p109r34\_20010517.gis**." Then, click "<u>OK</u>".

名前を付けて保存					? 🛛
保存する場所型:	🗀 data1		•	+ 🗈 💣 📰	
最近使ったファイル デスクトップ マイ ドキュメント マイ コンピュータ マイ ネットワーク	□         ¬109734_20010           □         ¬109734_20010           □         ¬109734_20010           □         ¬109734_20010           □         □109734_20010           □         □109734_20010           □         □17109034_03422           □         □17109034_03422           □         □17109034_03422           □         □17109034_03422           □         □17109034_03422           □         □71109034_03422           □         □71109034_03422	0517.gis 1517.sta 1517.tti 0010517_B10.sta 0010517_B10.TTF 0010517_B20.TTF 0010517_B30.TTF 0010517_B40.TTF 0010517_B50.TTF			
	ファイル名(N): ファイルの種類(T):	cut_17_09r34_20010517.gis All Files (*.*)		•	保存( <u>S</u> ) キャンセル

Chart 4.2.5-3 Output file

(4) Open the created clipping file. Select "<u>Open Image</u>" in "File Menu" and select the created file "**cut\_17\_p109r34\_20010517.gis**" (Chart 4.2.5-4).

ファイルを開く						? 🛛
ファイルの場所①:	🗀 data1		•	+ 🗈 🖻	* 📰 -	
最近使ったファイル ビン デスクトップ マイドキュメント マイ ニンピュータ	□         cut_17_p109/34_20           □         109/34_20010           □         109/34_20010           □         17_p109/34_03420           □         L71109034_03420           □         L71109034_03420           □         L71109034_03420           □         L71109034_03420           □         L71109034_03420	0010517.ets 1517.sis 1517.tif 1010517_B10.TIF 1010517_B20.TIF 1010517_B30.TIF 1010517_B40.TIF 1010517_B40.TIF				
マイ ネットワーク	ファイル名(N):	cut_17_p109r34_20010517.gis			•	■■■
	ファイルの種類(工):	Thematic (*.gis;*.tif)			•	キャンセル
		□ 読み取り専用ファイルとして開く	( <u>R</u> )			
Open image as: defa	ult	•				
Select Image.						

Chart 4.2.5-4 Selecting an image

(5) Information of the selected image is shown on screen (Chart 4.2.5-5). Click "OK".

Set Thematic Display Specifications	
cut_l7_p109r34_20010517.gis Area to Display Start End	nterval
Line 2143 Column 1 2634	Magnification 1 1 1 1 Magnification 1 1 1 1 1 1 1 1 1
Palette: ERDAS .ttl file	Number classes: 9
Display: Classes	Number groups: 0
Display classes/groups: All	
Background color	
🔽 Display legend	
	Cancel OK

Chart 4.2.5-5 Information of the image

(6) The selected image is displayed (Chart 4.2.5-6).

![](_page_40_Figure_4.jpeg)

Chart 4.2.5-6 Clipped image by ROI

4.2.6 Statistical data processing after supervised classification

This section introduces the procedures of statistical data processing for each pixel in supervised classification images created in the previous section.

(1) the Statistical data processing is applied to the supervised classification of LANDSAT-7/ETM+ and LANDSAT-2/MSS images created by the same method as shown in the previous section.

![](_page_41_Figure_3.jpeg)

LANDAT-2/MSS (taken on May 27, 1973) LANDAT-7/ETM+ (taken on May 17, 2001)

Chart 4.2.6-1 Created images with supervised classification

(2) Make the images active for statistical data processing (click on the screen), and select "<u>List</u> <u>results</u>" in "Processor Menu". Chart 4.2.6-2 shows an example of selecting <u>LANDSAT-7/ETM+</u>.

![](_page_41_Figure_7.jpeg)

Chart 4.2.6-2 Statistical data processing-1

(3) Set the following things as Chart 4.2.6-3 shows.

- List results for following areas : Image selection
- Output result to : Disk file

Set List Results Specifications	
List results for following areas Training Test Image selection Selected Area Line 1 2143 1 Column 1 2634 1	Table type Class Class Closp Table units Clas
Summarize by (train/test only) Field Class Group	Output results to Text window Disk file Cancel

Chart 4.2.6-3 Statistical data processing-2

(4) Set the output file. An example in Chart 4.2.6-4 selects "cut\_l7\_p109r34\_20010517.txt."

![](_page_42_Picture_6.jpeg)

Chart 4.2.6-4 Result files of statistical data processing

(5) "cut\_l7\_p109r34\_20010517.txt" is a textfile, and can be viewed with text editors as below.

List Results 06-13-2010 22:13:08 (MultiSpecWin32\_3.25.2010)

Input Parameters:

Image file = 'cut\_l7\_p109r34\_20010517.gis'

Thematic Image Classes

0: background

- 1: water
- 2: Urban area
- 3: paddy field
- 4: agricultural field
- 5: waste land
- 6: golf field
- 7: broad leaf forest
- 8: needle leaf forest

Output Information:

# CLASS DISTRIBUTION FOR SELECTED AREA

	Thematic	Number			
	Image Class	Samples		Percent	Area (Sq. meters)
1	background	0		0.00	0.0
2	water	3,734,513		66.50	3,361,061,700.0
3	Urban area	74,300	)	1.32	66,870,000.0
4	paddy field	93,447	,	1.66	84,102,300.0
<b>5</b>	agricultural field	25,988	5	0.46	23,389,200.0
6	waste land	4,038	5	0.07	3,631,500.0
7	golf field	2,527		0.04	$2,\!274,\!300.0$
8	broad leaf forest	777,148	3	13.84	699,433,200.0
9	needle leaf forest	903,751	16.09	813,37	5,900.0
	Total	5,615,709	)	100.00	5,054,138,100.0
0 CPU se	conds for results listi	ng. 06-13-2010	22:13:08		

(6) Apply the same statistical data processing to the other LANDSAT-2/MSS image (cut\_l2\_p117r34\_19730527.txt).

List Results 06-14-2010 22:13:08 (MultiSpecWin32\_3.25.2010) Input Parameters: Image file = 'cut\_l2\_p117r34\_19730527.gis' Thematic Image Classes 0: background 1: water 2: Urban area 3: paddy field 4: agricultural field 5: waste land 6: golf field 7: broad leaf forest 8: needle leaf tree forest

# Output Information: CLASS DISTRIBUTION FOR SELECTED AREA

	Thematic	Number		
	Image Class	Samples	Percer	nt Area (Sq. meters)
1	background	0	0.0	0.0
2	water	935,648	66.5	3,368,296,800.0
3	Urban area	6,820	0.4	8 24,552,000.0
4	paddy field	37,944	2.7	136,598,400.0
<b>5</b>	agricultural field	6,121	0.4	3 22,035,600.0
6	waste land	1,932	0.1	3 6,955,200.0
7	golf field	0	0.0	0.0
8	broad leaf forest	$242,\!253$	17.2	872,110,800.0
9	needle leaf tree forest	175,985	12.5	633,546,000.0
	Total	1,406,693	100.0	0 5,064,094,800.0
0 CPU s	econds for results listing.	06-14-2010	22:13:08	

As a result, interannual change in forest area is detected (See Table 4.2.6-1).

	1973	2001	change (based in 1973)
Broadleaf-tree area (km²)	872.11	699.43	-172.68
Needleleaf-tree area (km $^2$	633.55	813.38	179.83
Total (km <sup>2</sup> )	1505.66	1512. 81	7.15

Table 4.2.6-1 Secular change of forest area in Nanao Bay area

LANDSAT data in Toyama Bay area (Table 4.1-2) is also processed. Then, the images of Land Cover Classification with supervised classification can be viewed. (Chart 4.2.6-1 and 4.2.6-2).

![](_page_45_Figure_1.jpeg)

Chart 4.2.6-1 Result of Land Cover Classification with supervised classification by LANDSAT data (taken on Oct. 5, 1972)

![](_page_45_Figure_3.jpeg)

Chart 4.2.6-2 Result of Land Cover Classification with supervised classification by LANDSAT data (taken on Oct. 5, 2000)

	1972	2000	change (based in 1972)
Water area (km2)	975.55	905.72	-69.83
Rice field $(km^2)$	349.19	262.37	-86.82
Urban area (km²)	218.08	445.27	227.18
Vegetable field $(km^2)$	29.67	12.13	-17.54
Golf field $(km^2)$	0.00	5.68	5.68
Wasteland (km2)	3.24	3.44	0.20
Broadlead-tree area $(km^2)$	248.35	98.35	-150.00
Needleleaf-tree area $({ m km}^2)$	143.82	207.24	63.42
Others (cloud) $(km^2)$	0.00	26.10	26.10
Total (km <sup>2</sup> )	1967.90	1966.29	-1.61

Using the results of the supervised land cover classification shown above, interannual change of land cover in Toyama Bay area is analyzed. The result of the analysis is shown in Table 4.2.6-2.

Chart 4.2.6-2 Secular change of land cover in Toyama Bay area

The analysis result shows that as time passes (from 1972 to 2000), urban area including new golf fields has been significantly expanded, and agricultural area ( rice and vegetable fields) and water area have been decreased. Also, while broad-tree area has been considerably decreased, needle-tree area has been increased.

#### 5. References

The software "MultiSpec" used in the handbook is a free software which was developed by Purdue University, U.S.A. Although, there are no restrctions for its public use, all rights of the software are reserved by the Purdue University, USA.

Agriculture, Forestry and Fisheries Research Information Technology Center also provides overview of MultiSpec Manual and sample data in Japanese (<u>http://www.affrc.go.jp/satellite/MultiSpec/</u>).