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TEACHING AID FOR REMOTE SENSING AND MAP IMAGERY ANALYSIS USING EXCEL SPREADSHEET AND VBA

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ABSTRACT: Remote sensing and map images are helpful teaching aid for environmental studies. Students can research an actual information of environment by analysis of these images. However, it was difficult to analyze the imagery using conventional programming method. Microsoft-Excel spreadsheet provides a quick and powerful way. We have developed data set for the purpose and scripts using VBA (Visual Basic for Application). An image data transfer from the data set to a worksheet by clicking of Web-icon. Cell data on the worksheet are calculated by manually or VBA scripts. There are two manners of imagery operations. One is conversion operation, another statistical analysis operation. Results of these operations provide some information of particular area environment. Excel is frequently available on any type computers and consequently students can study environment analysis easily.

1. INTRODUCTION

Remote sensing satellite imagery and map data are suitable for environment education. We looked about teaching aid for a method of imagery analysis using personal computer. Although typical programming language C is versatile, exercise required in long time for students. Commercial software for imagery analysis, e.g., ERDAS-IMAGINE, it also took them long time to exercise. Excel and VBA solved the problem. Of course, the use of these spreadsheets in science teaching is not new (Webb, 1993). The power and simplicity of a spreadsheet are that the data being manipulated are held in front of the user in a very direct and accessible manner (Cooke, 1997). Therefore, We have developed a data set and some VBA scripts for imagery analysis.

2. IMAGERY DATA SET

Fig. 1. shows 72x62 pixel's images in the data set displayed by WWW browser (Sato, 2000). The images that have statistical values are icons for link to corresponding CSV (Comma- Separated Values) numerical format data. These CSV images data made from original images that location is Iwate prefecture of Japan, east longitude is from 141 to 141.996 degrees and north latitude is from 38.823 to 39.833 degrees. These images are precision geometrical corrected, projected to UTM and 30m resolution (Iikura, 1998). CSV formatted images data are as follows

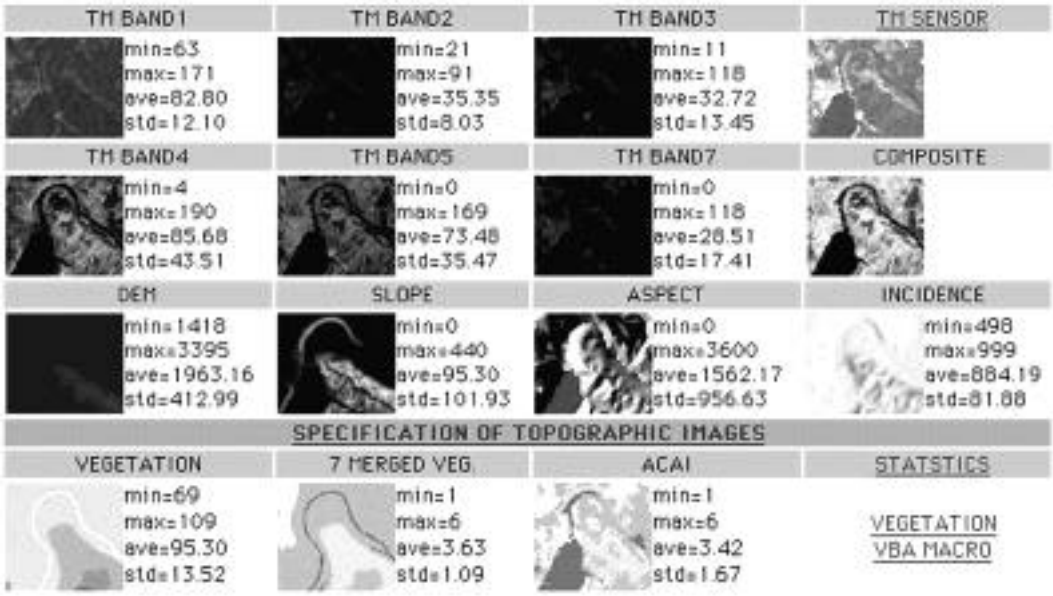

Figure 1. TM and map data set.

1) Landsat TM images:
   Band 1,2,3,4,5 and 7
2) Topographical maps:
   Digital elevation model (DEM) with 0.1m height precision
   Slope angle map derived from DEM with 0.1° precision
   Aspect angle map derived from DEM with 0.1° precision
   Sunlight incidence angle map derived from above data and incidence and zenith angle
3) Vegetation maps:
   Actual vegetation map (1978-1985) edited by Japan Environmental Agency
   Land cover map generated from above vegetation map
   Automatic classification land cover map made from TM images and land cover map (Sato, 1999)

3. IMAGERY ANALYSIS USING EXCEL

3.1 Image conversion operation

The location of the pixel value is shown as

Sheet-name!Cell-position

Cell-position is a composition name of row and column, such as A1, B1, ... Z1,...AA1. For example, worksheet name TM4 has a 72x62 pixel image data from A2 to BT63 cell-position, left-up corner show TM4!A2. In the Image conversion operation, a new image made from original images by pixel operation. For example, NDVI image will make by TM band 3 and band 4 data and ratio operation. If the each data transferred to TM4 and TM3 worksheet, worksheet name NDVI A2 cell has a following numerical expression.

=(TM4!A2-TM3!A2)/(TM4!A2+TM3!A2)

The expression can copy from A2 to anywhere in the worksheet. The copy operation will be change cell-position name corresponding to copied cell position. A new NDVI image made by the expression copy operation at a requirement worksheet area.

In the general, conversion operation is shown as

Sn(RnCn)=fc(S1(R1C1),S2(R2C2),...Sk(RkCk))

Sn is a target worksheet name. S1,S2, … Sk is source (operand) image of the conversion. R1C1 is row-column cell position of the sheet. The function fc is conversion numerical expression. Examples of the conversion operation are NDVI, logical selection, enhancement, spatial filtering and resampling. Ordinarily the fc write to requirement cell area by manual work. If target or operand worksheet name and cell positions defined, VBA is available for the operation.

3.2 Image statistics analysis operation

In the environment study, students require a statistical value the show a feature of the image data area. For example, If average value of worksheet image area from A1 to J9 cell-position, following expression will write to a cell.

=AVERAGE(S1!A1:J9)

In the general, statistical analysis operation is shown as

Sn(RnCn)=fe(S1(R1C1:R2C2))

Sn(RnCn) is target worksheet and cell name to present statistical analysis value. S1(R1C1:R2C2) are source (operand) image sheet name and area position. The function fe is statistical analysis numerical expression. The statistical analysis value, such as minimum, maximum, total, frequency or linear regression values use for evaluation of the environment.

4 IMAGE ANALYSIS USING VBA

4.1 Conversion operation using VBA

In the conversion operation, a numerical expression will write to requirement cell area. For example, there is an expression at the A2, following VBA script (procedure name: formula_copy) will be copied A2 cell expression to every 72x62 cell's area in the worksheet.

```
Sub formula_copy()
  Range("A2").Select
  Selection.Copy
  Range("A2:BT63").Select
  Selection.PasteSpecial Paste:=xlFormulas
  Application.CutCopyMode = False
End Sub
```

If conversion expression has '$' prefixed cell position name, the cell position does not change by copy operation. Typical conversion operation expressions are follows.

(Each expression will write at A2 cell position, and S1 is operand worksheet name)

(1) Scale conversion with limit value

=IF($A$1*S1!A2>$B$1,$B$1,$A$1*S1!A2)

Cell A1 has a gain value, B1 limit value. If operation result is over than limit value, result is the limit value.

(2) 3x3spatial filtering

=S1!A2*$A$1+S1!B2*$B$1+S1!C2*$C$1+S1!A3*$D$1+S1!B3*$E$1+

S1!C3*$F$1+S1!A4*$G$1+S1!B4*$H$1+S1!C4*$I$1

This expression shows a filtering in the domain of image space. Spatial filter values are write from A1 to I1. Edge of the image can not calculate.

(3)Level slice

=IF(S1!A2>B2,1,0)

If pixel value is bigger than B2 cell value, then new image pixel is 1, else 0.

(4) Boolean operation

=IF(AND(VEG!A2=3,DEM!A2>1100),TM4!A2,"")

Vegetation item number is 3 and elevation is over than 1100, then copy data the A2 cell from TM4 worksheet, else empty.

4.2 Statistics analysis operation using VBA

VBA can allocate a cell to a certain expression of statistical analysis function and consequently worksheet has a display form of observation of environment. Sometimes VBA will make statistical analysis procedure for specified purpose. Fig.2. shows statistical results of a specified vegetation using VBA.

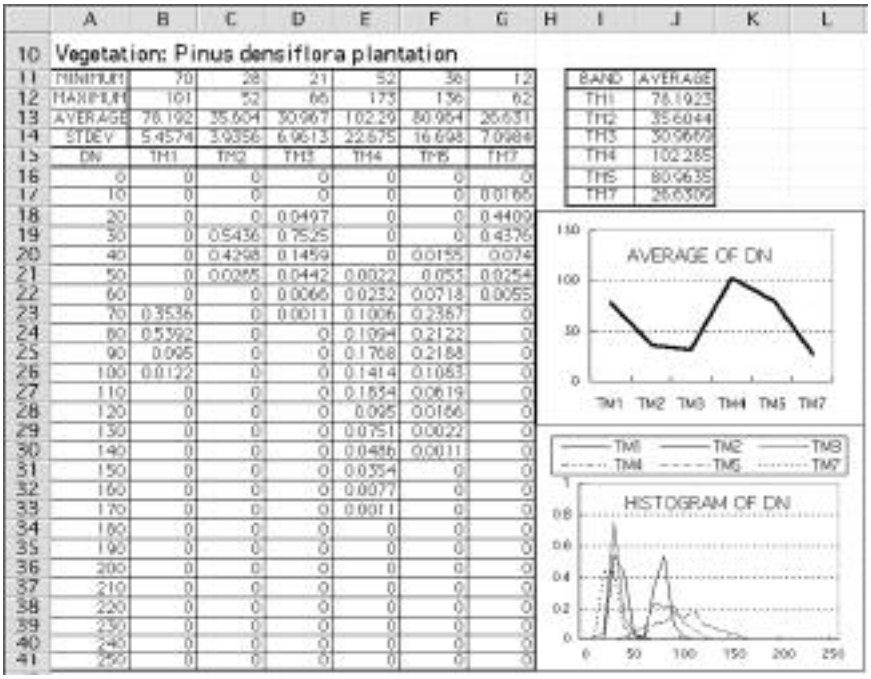

Figure 2. Histogram and average of DN about red deal plantation.

4.3 Graphic display using VBA

There are three graphic display methods for Excel worksheet image data as a thematic map. First is conditional formatting. This method is simple and fast. This method can show colored cell up to three colors. Following VBA script is setup code for conditional formatting with 72x62 pixel's size.

```
Sub colored_by_format()
```

```
 Range("C6:BV67").Select
 Selection.FormatConditions.Delete
 Selection.FormatConditions.Add Type:=xlCellValue, Operator:=xlBetween, _
    Formula1:="=$B$2", Formula2:="=$B$3"
 Selection.FormatConditions(1).Interior.ColorIndex = Range("A3").Interior.ColorIndex
 Selection.FormatConditions.Add Type:=xlCellValue, Operator:=xlBetween, _
    Formula1:="=$B$4", Formula2:="=$B$5"
 Selection.FormatConditions(2).Interior.ColorIndex = Range("A5").Interior.ColorIndex
 Range("B1").Select
End Sub
```

Second is contour graph. Excel 3D graph function has some option.
Last method is re-assignment color code by VBA. Excel can display up to 56 colors. If the color assignment changed, student can graphical display all the cell as pseudo color map. For example, next VBA script assigns to color code number 1 assign to light blue, code 56 assigns to dark brown.

```
Sub Blue_Brown_color_index_assignment()
 For i = 1 To 56
 v1 = 110 * (1 - Sin(i * 6.28 / 56))
 v2 = 250 * Cos(i * 1.57 / 60)
 v3 = 200 * Exp(-i / 10)
 ActiveWorkbook.Colors(i) = RGB(v1, v2, v3)
 Next i
End Sub
```

After the re-assignment procedure, cell interior can change require color corresponding itself numerical value using VBA. The graphics image will be displayed by decreased row and column size for whole observation.

4-4 Data load using VBA

When require many image's data loading, the VBA is very helpful. A CSV image data transferred to a temporary worksheet and then the data transferred to a target worksheet. At the last, temporary worksheet will be closed. In case of double area size analysis, four CSV image data will transfer to a target worksheet using VBA. An example of VBA is as follows.

```
Sub loadex()
 fname$ = Cells(1, 1)       'File name filled at A1 cell
 For j = 0 To 3
  Select Case j
  Case 0
   sp$ = "TM42"            'Area name ( sub directory name )
   dp$ = "A2:BT63"         'target worksheet cell area
  Case 1
   sp$ = "TM43"
```

```
    dp$ = "BU2:EN63"
  Case 2
    sp$ = "TM52"
    dp$ = "A64:BT125"
  Case 3
    sp$ = "TM53"
    dp$ = "BU64:EN125"
  End Select
     'For Windows PC. if Machintosh, change delimitter : instead of \
  loadfile$ = "C:\WINDOWS\Desktop\CDROM\A92\" & sp$ & "\" & fname$ & ".CSV"
  aw_name$ = ActiveWorkbook.Name  'Target worksheet
  Workbooks.Open Filename:=loadfile$
  bw_name$ = ActiveWorkbook.Name            'Temporary worksheet
  Range("a2:bt63").Copy
  Windows(aw_name$).Activate
  Range(dp$).Select
  ActiveSheet.Paste
  Range("a100").Copy     'For automatic close
  Range("a1").Select
  Windows(bw_name$).Close
 Next j
End Sub
```

5. CONCLUSION

The imagery data set and VBA script used at the Ichinoseki national college of technology to study some environmental characteristics and analysis method. For example, students can study for seasonal change of vegetation's, sunlight effect of TM images using topological maps and the distribution of a vegetation in a specified area. Imagery analysis exercise for beginner students included lecture of TM sensor and spreadsheet operation was less than two months. The EXCEL spreadsheet is effective teaching aid for college students.

7. REFERENCES

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