

GRDSS: Development and Applications

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AGENDA

FOSS

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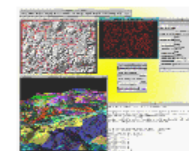
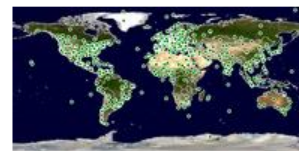


Welcome to GRASS GIS

You are at an official GRASS site (other [mirror sites](#))
This site is updated daily: 13 Nov 2009

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Celebrating 25 years!



GRASS User map ([without pop-up](#))

Geographic Resources Analysis Support System

Commonly referred to as GRASS, this is free Geographic Information System (GIS) software used for geospatial data management and analysis, image processing, graphics/maps production, spatial modeling, and visualization. GRASS is currently used in academic and commercial settings around the world, as well as by many governmental agencies and environmental consulting companies. GRASS is an official project of the [Open Source Geospatial Foundation](#).

Module of the day:

[v.support](#) Updates vector map metadata.

Latest News! [XML](#) [RSS FEED](#)

- 18 Sep 2009: [GRASS 6.4.0 module synopsis published](#) - A list of all modules with GUI menu locations
- 11 Jun 2009: [GRASS 6.4.0 RC5 released](#) - Fifth release candidate of stable release 6.4.0 which includes the new graphical user interface, native MS-Windows support new functionality and bugfixes
- 03 Jun 2009: [New WinGrass 6.4.0RCsvn stand-alone package](#) - Please help test!
- 29 Apr 2009: [OSGeo welcomes 20 Google Summer of Code students](#) - Including 3 GRASS projects

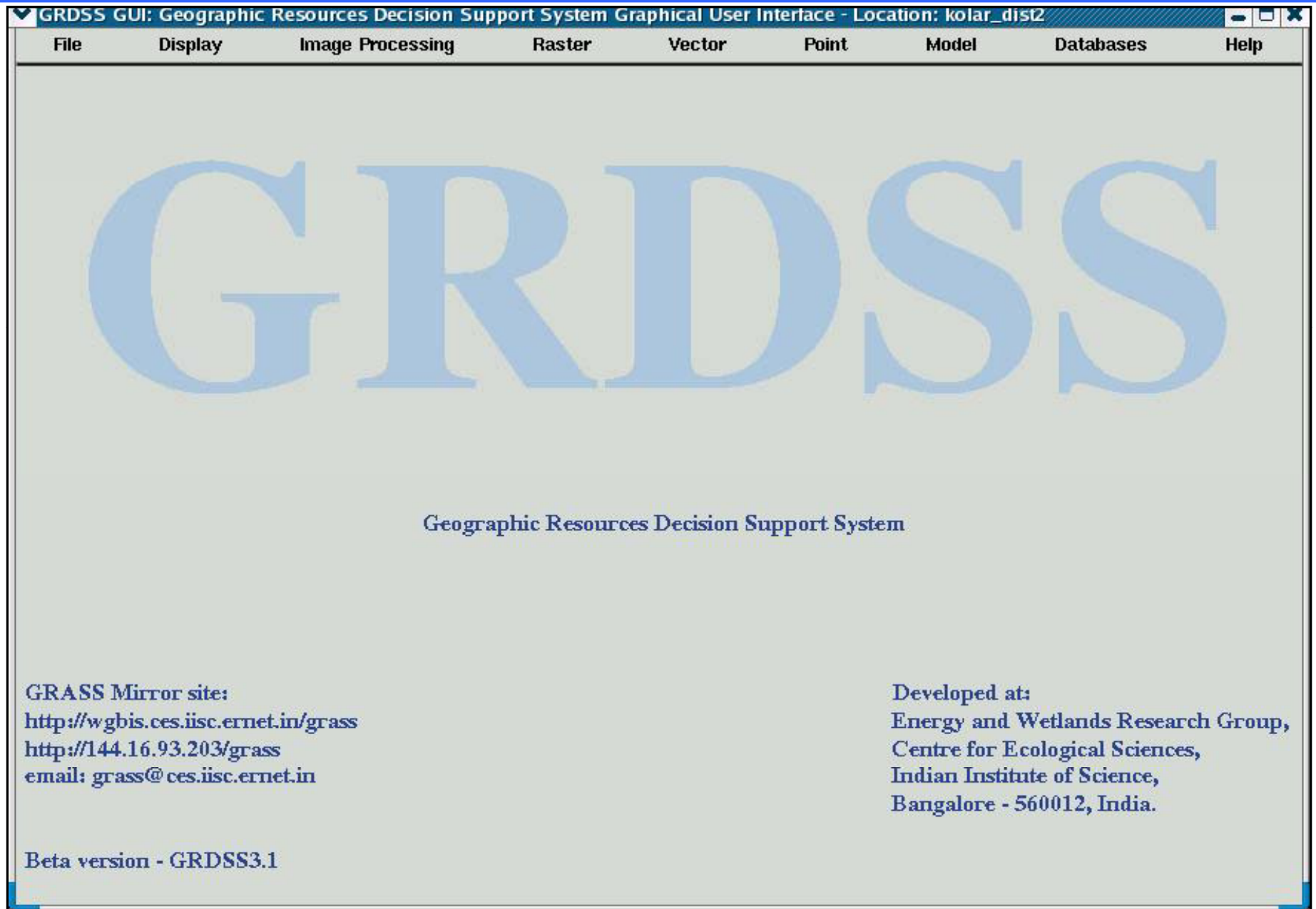
Upcoming GRASS/FOSS4G related events: [XML](#) [RSS FEED](#)

- [Geoinformatics FCE CTU 2009 - Free and Open Source Software in Geoinformatics](#) - 17-18 Sep 2009, Prague, Czech Republic
- [FOSS4G 2009 in Sydney - Free and Open Source Software for Geospatial](#) - 20-23 Oct 2009, Sydney, Australia

GRDSS: Journey in 2003



GRDSS in 2004



FOSS KIOSK

The background of the slide is a dark gradient, transitioning from black on the left to a dark grey on the right. On the right side, there are several bright, diagonal streaks of light in shades of green and blue, creating a sense of motion and technology.

Welcome to Free & Open Source Software (FOSS) at CES, IISc, Bangalore, India

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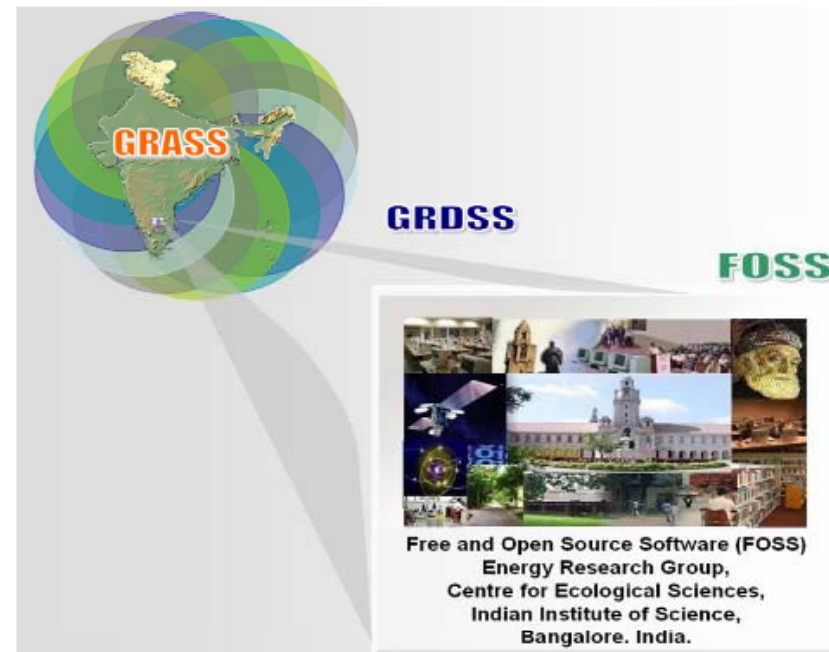
[Geographic Resources Decision Support System](#)

GEOVISUALISATION OF CHERUVANNUR VILLAGE PANCHAYAT, KOZHIKODE, KERALA, INDIA

NEW

Open Source GIS in India, Discussion Meeting, 16th November 2009, CiSTUP, IISc

NEW

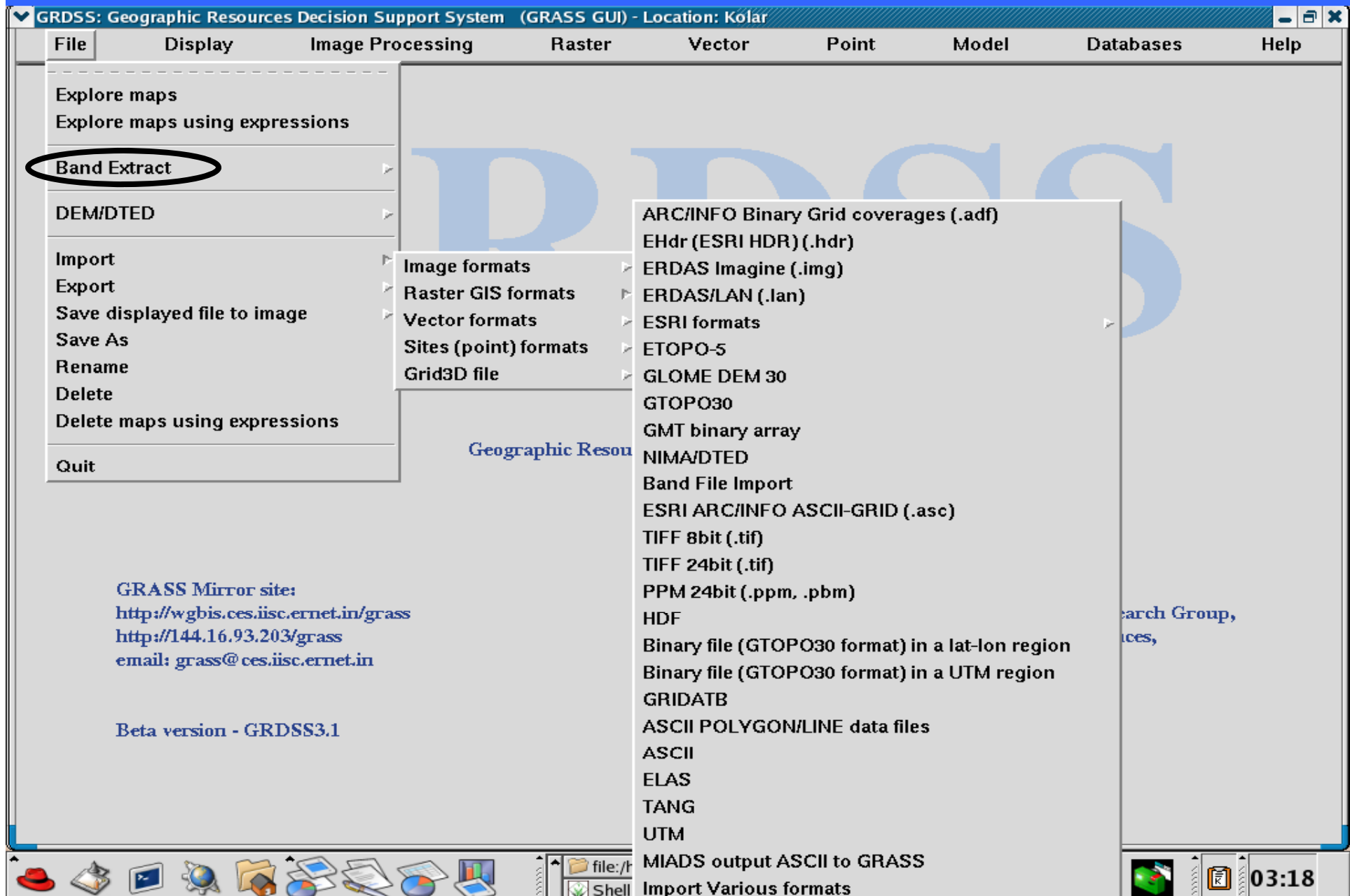


Good Evening! The time is 7:07 pm (IST). Thursday, 12 November, 2009.
Best viewed under Browsers: Firefox 2.0+, IE 7 at 800 x 600 and above.
Web designed by Uttam, Energy Research Group, CES, IISc.

Development

- FOSS website
- Band extraction modules in GRDSS – LISS III and PAN
- Image fusion modules – HIS, Brovey, High Pass Filter, High Pass Modulation, Principal Component Analysis, Fourier Transform, Atrous, MRAIM, Gram Schmidt, CN Spectral, Luminance Chrominance
- Forest fragmentation module – Patch, Transitional, Edge, Perforated, Interior
- Urban fragmentation module – Developed, Non-developed, Water, Infill, Expansion, Outlying growth

GRDSS: LISS III and PAN band extraction



NRSA information Help

NRSA (National Remote Sensing Agency)

NRSA (National Remote Sensing Agency) at Hyderabad is a Department of Space sponsored organization, that is engaged in carrying out satellite and airborne remote sensing activities including aerial photography, digital photogrammetry, and microwave remote sensing, etc. The main objective of NRSA is the acquisition, processing and dissemination of Remote Sensing data.

Indian Remote Sensing Satellites

Indian Remote Sensing Satellites (IRS-1A, IRS-1B, IRS-1C and IRS-1D) has strengthened the scope of Remote Sensing capabilities of India. IRS-1C and IRS-1D data is received at the earth station of NRSA, Hyderabad and then supplied to users on request. IRS-1D has three cameras: (1) a Panchromatic camera (2) a Linear Imaging Self-Scanning Sensor - III (LISS-III) (3) a Wide Field Sensor (WIFS)

DATA REQUEST FROM NRSA

Data from Integrated Information Management System (IIMS) at NRSA Data Centre (NDC) provide services to the users of the satellite images. NRSA data request can be made in three ways:

1. Digital browse facility - LISS-III and PAN images are generated and compressed after acquisition and transferred to NDC (NRSA Data Centre) in optical jukebox. Based on user input the requested data is retrieved from the jukebox, decompressed and displayed with the Digital browsing facility.
2. Referencing scheme maps- Reference scheme maps are generated with path/row and scene centre marked on a baseline map to assist users in identifying the area of interest. The referencing scheme map for IRS-1C is provided to users in three different types:
 - 1.) for India and neighbouring countries on 1 : 6,000,000 scale,
 - 2.) six zones of India, viz. Central, North, South, East, West and Andaman and Nicobar on 1 : 4,500,000 scale and
 - 3.) the entire coverage of Hyderabad earth station.
3. orbital calendar - orbital calendar, giving the details of paths covered on different days, is useful to users to plan their procurement of satellite data products. It is possible to know, on which day the required data have been collected or are going to be collected.

Typical IRS-1C orbital calendar

Day	Path number																							
1	1	318	294	270	246	222	198	174	150	126	102	78	54	30										
2	6	323	299	275	251	227	203	178	155	131	107	83	59	35										
3	11	328	304	280	255	232	208	184	160	136	112	88	64	40										
4	16	333	309	285	261	237	213	189	165	141	117	93	69	45										
5	21	338	314	289	265	242	218	194	170	146	122	98	74	50	26									
6	2	319	295	270	247	223	199	175	151	127	103	79	55	31										
7	7	324	300	271	252	228	204	180	156	132	108	84	60	36										
8	12	329	305	276	257	233	209	185	161	137	113	89	65	41										
9	17	334	310	281	262	238	214	190	166	142	118	94	70	46										
10	22	339	315	286	267	243	219	195	171	147	123	99	75	51	27									
11	3	320	296	271	248	224	200	176	152	128	104	80	56	32										
12	8	325	301	272	253	229	205	181	157	133	109	85	61	37										
13	13	330	306	282	258	234	210	186	162	138	114	90	66	42										
14	18	335	311	287	263	239	215	191	167	143	119	95	71	47										
15	23	340	316	292	268	244	220	196	172	148	124	100	76	52	28									
16	4	321	297	273	249	225	201	177	153	129	105	81	57	33										
17	9	326	302	278	254	230	206	182	158	134	110	86	62	38										
18	14	331	307	283	259	235	211	187	163	139	115	91	67	43										
19	19	336	312	288	264	240	216	192	168	144	120	96	72	48	24									
20	24	341	317	293	269	245	221	197	173	149	125	101	77	53	29									
21	5	322	298	274	250	226	202	178	154	130	106	82	58	34										
22	10	327	303	279	255	231	207	183	159	135	111	87	63	39										
23	15	332	308	284	260	236	212	188	164	140	116	92	68	44										
24	20	337	313	289	265	241	217	193	169	145	121	97	73	49	25									
25	1	318	294	270	246	222	198	174	150	126	102	78	54	30										

Indian users send their request details like area of interest, date/period of interest and sensor. The requests are studied and prioritized, depending upon the various factors. NDC (NRSA Data Centre) then sends the acquisition plan to Spacecraft Control Centre (SCC), where the necessary plans are worked out and after a successful acquisition of a pass, a scene is processed according to the user's requirements and delivered to the user.

For more information log on to: <http://www.nrsa.gov.in>
Postal address: National Remote Sensing Agency,
(Dept. of Space), Govt. of India,
Balakrishna, Hyderabad-500037,
India.

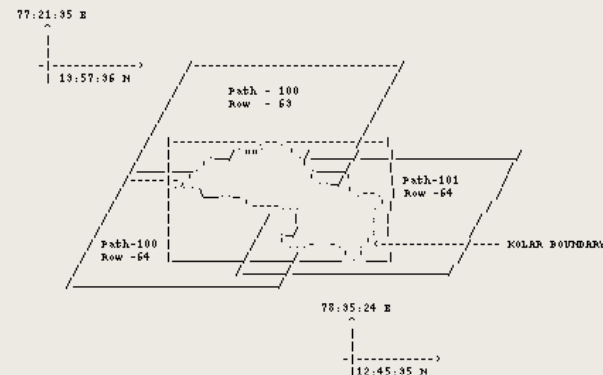
OK

NRSA information Help

57 N - 13
57 K - 1,2,3,4,6,7,8,11,12
57 L - 1,5

Data Required:

Date	Satellite id	Sensor	Path	Row
04-JAN-2004	1D	LISS 3	100	63
04-JAN-2004	1D	LISS 3	100	64
01-JAN-2004	1D	LISS 3	101	64



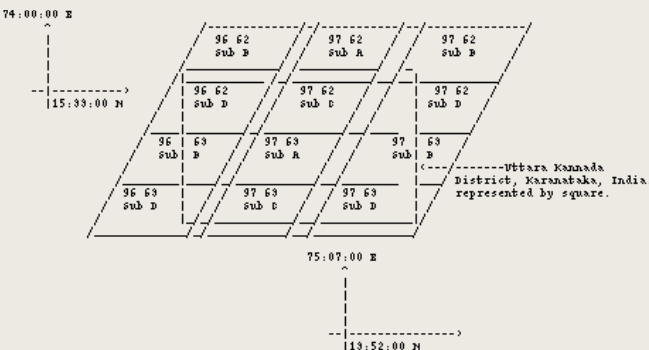
Let us take another example, Suppose we need to buy scenes for Uttara Kannada District, Karnataka.

The toposheet numbers we require are:
(scale - 1:250,000) - 48 L, 48 M, 48 N, 48 O
(scale - 1:50,000) - 48 L - 6,7,8,9,10,11,12,13,14,15,16
48 M - 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16
48 N - 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16
48 O - 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16

Data Required:

Panchromatic Data:

Date	Satellite id	Sensor	Path	Row	Sub-scene
17-OCT-2003	1D	PAN	96	62	D
17-OCT-2003	1D	PAN	96	62	D
17-OCT-2003	1D	PAN	96	63	D
17-OCT-2003	1D	PAN	96	63	D
28-OCT-2003	1D	PAN	97	62	D
04-OCT-2003	1D	PAN	97	62	D
04-OCT-2003	1D	PAN	97	63	D
28-OCT-2003	1D	PAN	97	63	D
04-OCT-2003	1D	PAN	97	63	D



r.in.pan

Extract The PAN DATA

Input [File Name Of The File Containing PAN Data] : file

Input [File Name Of The Leader File] : file

Output [File Name For Output Data] : raster

r.in.pan

PAN Data Extract Help

PAN DATA EXTRACT HELP

This Module extracts the band file (that is the output of band extraction module) from PAN data into GRASS GIS.

Guidelines For Use of Above Module

Please click on <PAN Data Extract> As Following :

File----->Band Extract----->PAN Data Extract

#1. In imagery row, type the file name which contain the bands data with complete path. Generally name of the file is <IMAGERY.L-3> under the PRODUCT1 directory of NRSA DATA CD.

#2. In leader row, type the file name for leader file with complete path. Generally name of the file is <LEADER.L-3> under the PRODUCT1 directory of NRSA DATA CD. This File contain all the details about the data.

#3. In output file name type the name of the file, you want to assign to the PAN image.

Also see the manual page of PAN data extract (man pandataextract; eg:- GRASS:> man pandataextract)

r.in.LISS3.sh

GRDSS Band Extraction module - Extract The Bands From NRSA

Input [File Name Of The File Containing All The 4 Bands Data] : file

Input [File Name Of The Leader File] : file

Output [File Name For Band 1 Data] : raster

Output [File Name For Band 2 Data] : raster

Output [File Name For Band 3 Data] : raster

Output [File Name For Band 4 Data] : raster

☐ Only Extract [Default: extract and convert to GRASS].

r.in.LISS3.sh

LISS III Data Import Help

LISS III IMPORT HELP

This module extract all the four bands from LISS III data. It saves each bands as a individual file and also generate the documentary file corresponding to each band file which contain the detail information about the data. Such that; No. of column, No. of rows, band No., data type etc.

The module automatically takes the name of document file from the band file name and add an extension (.doc).

For example : If user give the file name for first band of data <xyz>, the module will automatically generate a file having name <xyz.doc> as a documentary file for first band.

Guidelines For Use of Above Module

Please click on <LISS 3 Band Extract> As Following :

File----->Band Extract----->LISS 3 Band Extract

#1. In imagery row, type the file name which contain all the four bands data with complete path. Generally name of the file is <IMAGERY.L-3> under the PRODUCT1 directory of NRSA DATA CD.

#2. In leader row, type the file name for leader file with complete path. Generally name of the file is <LEADER.L-3> under the PRODUCT1 directory of NRSA DATA CD. This File contain all the details about the data.

#3. In Band1 row, type the name of the file, you want to give for first band of data.

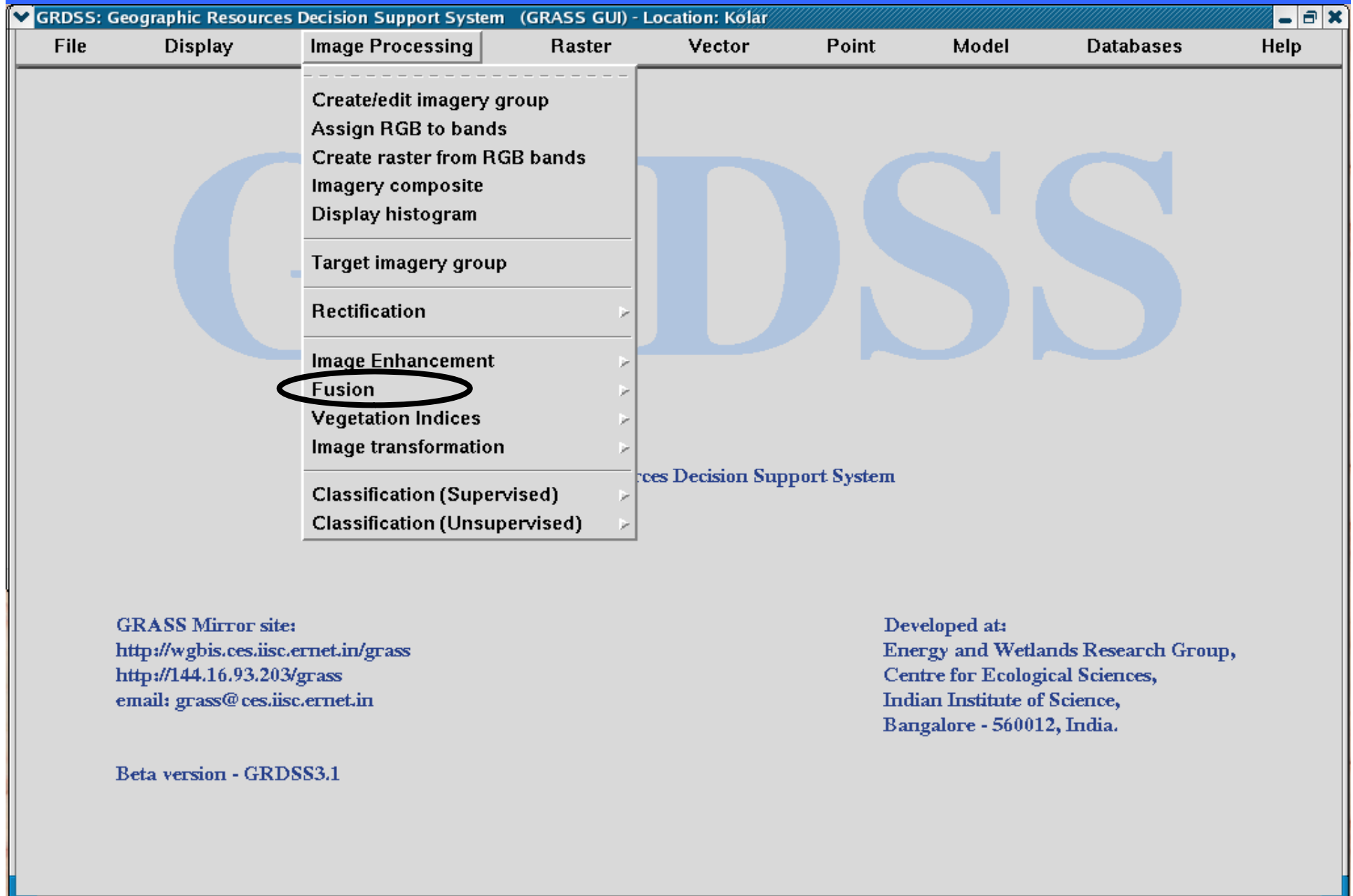
#4. In Band2 row, type the name of the file, you want to give for second band of data.

#5. In Band3 row, type the name of the file, you want to give for third band of data.

#6. In Band4 row, type the name of the file, you want to give for fourth band of data.

Also see the manual page of LISS 3 band extract (man liiss3bandextract; eg:- GRASS:> man liiss3bandextract)

GRDSS: Image Fusion



RGB-HIS Fusion

■ RGB bands are transformed to HIS (Carper et al., 1990)

(hue – dominant or average wavelength of light contributing to a colour,
intensity – total brightness of the colour,
saturation – purity of colour relative to gray)

$$\begin{pmatrix} DN_{PAN}^I \\ V_1 \\ V_2 \end{pmatrix} = \begin{pmatrix} \frac{1}{3} & \frac{1}{3} & \frac{1}{3} \\ -\frac{1}{\sqrt{6}} & -\frac{1}{\sqrt{6}} & \frac{2}{\sqrt{6}} \\ \frac{1}{\sqrt{6}} & -\frac{1}{\sqrt{6}} & 0 \end{pmatrix} \begin{pmatrix} DN_{MS1}^I \\ DN_{MS2}^I \\ DN_{MS3}^I \end{pmatrix}$$

where DN_{MS1}^I , DN_{MS2}^I , DN_{MS3}^I are the low resolution bands
 V_1 , V_2 are the intermediate variables.

Carper, W. J., Lillesand, T. M., and Kieffer, R. W., 1990, The use of Intensity-Hue-Saturation transformations for merging SPOT Panchromatic and multispectral image data. *Photogrammetric Engineering and Remote Sensing*, 56, 459-467.

RGB-HIS Fusion

$$I = DN_{PAN}^l \quad H = \tan^{-1} \left(\frac{V_2}{V_1} \right) \quad S = \sqrt{V_1^2 + V_2^2}$$

- *I is replaced with high spatial resolution image – $DN_{PAN}^{h'}$ (contrast stretched to I) which is to be integrated.*

$$DN_{new_image} = \frac{\sigma_{ref}}{\sigma_{old}} (DN_{old} - \mu_{old}) + \mu_{ref}$$

$$\begin{pmatrix} DN_{MS1}^h \\ DN_{MS2}^h \\ DN_{MS3}^h \end{pmatrix} = \begin{pmatrix} 1 & \frac{-1}{\sqrt{6}} & \frac{3}{\sqrt{6}} \\ 1 & \frac{-1}{\sqrt{6}} & \frac{-3}{\sqrt{6}} \\ 1 & \frac{2}{\sqrt{6}} & 0 \end{pmatrix} \begin{pmatrix} DN_{PAN}^{h'} \\ V_1 \\ V_2 \end{pmatrix}$$

where DN_{MS1}^h , DN_{MS2}^h , DN_{MS3}^h are the fused high resolution multispectral bands.

RGB-HIS Fusion

i.rgb.his

RGB to HIS raster map color transformation function

Input raster map representing RED: raster

Input raster map representing GREEN: raster

Input raster map representing BLUE: raster

Output raster map representing HUE: raster

Output raster map representing INTENSITY: raster

Output raster map representing SATURATION: raster

i.rgb.his

i.his.rgb

HIS to RGB raster map color transformation function

Input raster map representing HUE: raster

Input raster map representing INTENSITY: raster

Input raster map representing SATURATION: raster

Output raster map representing RED: raster

Output raster map representing GREEN: raster

Output raster map representing BLUE: raster

i.his.rgb

Brovey Fusion

(Pohl, 1996)

$$\begin{pmatrix} DN_{MS1}^h \\ DN_{MS2}^h \\ DN_{MS3}^h \end{pmatrix} = \begin{pmatrix} DN_{MS1}^l \\ DN_{MS2}^l \\ DN_{MS3}^l \end{pmatrix} + (DN_{PAN}^h - DN_{PAN}^l) \begin{bmatrix} \frac{DN_{MS1}^l}{DN_{PAN}^l} \\ \frac{DN_{MS2}^l}{DN_{PAN}^l} \\ \frac{DN_{MS3}^l}{DN_{PAN}^l} \end{bmatrix}$$

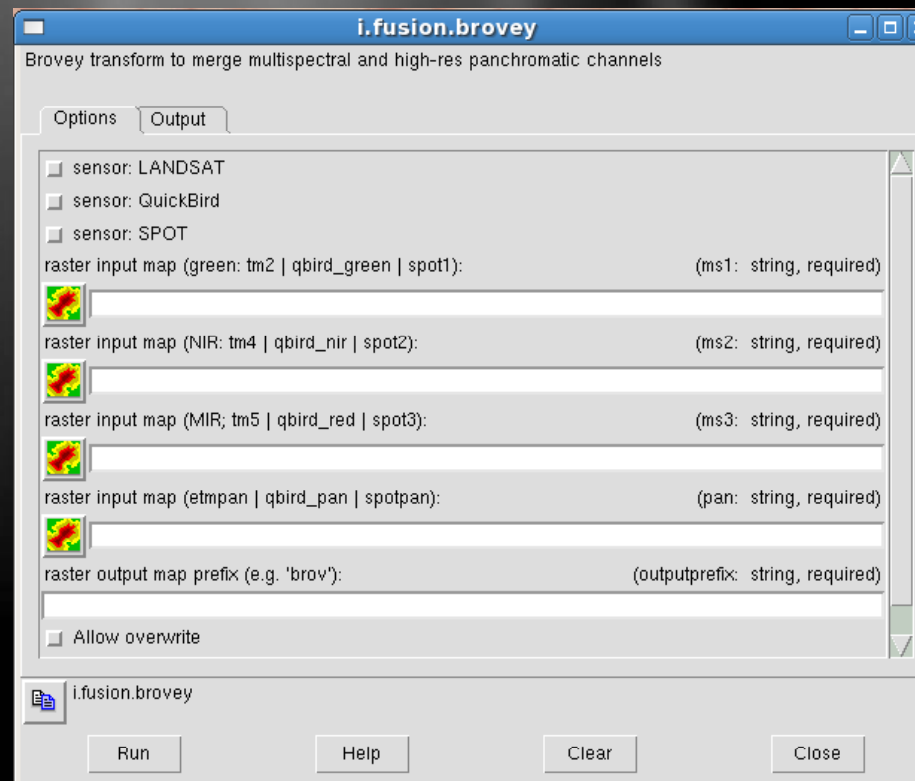
where

$$DN_{PAN}^l = (1/3)(DN_{MS1}^l + DN_{MS2}^l + DN_{MS3}^l)$$

$DN_{MS1}^l, DN_{MS2}^l, DN_{MS3}^l$ are the low resolution bands

$DN_{MS1}^h, DN_{MS2}^h, DN_{MS3}^h$ are the fused high resolution multispectral bands

Brovey Fusion



High Pass Filter Fusion

$$DN_{MSS}^h = DN_{MS}^l + (DN_{PAN}^h - DN_{PAN}^l)$$

where $DN_{PAN}^l = DN_{PAN}^h * h_0$ and h_0 is a LP filter (average or smoothing filter).

r.hpf

Raster file matrix filter.

Input multispectral raster band1: raster

Input multispectral raster band2: raster

Input multispectral raster band3: raster

Input multispectral raster band4: raster

Input multispectral raster band5: raster

Input multispectral raster band6: raster

Input multispectral raster band7: raster

Input high resolution map: raster

Output fused raster map: raster

ASCII low pass filter file: file

Number of times the filter is applied [1]:

☐ Run quietly.

r.hpf

low_pass_filter (~/.Filters) - gedit

File Edit View Search Tools Documents Help

New Open Save Print... Undo Redo Cut Copy Paste Find Replace

```
low_pass_filter *
TITLE 5x5 Low Pass
MATRIX 5
1 1 1 1 1
1 1 1 1 1
1 1 1 1 1
1 1 1 1 1
1 1 1 1 1
DIVISOR 25
TYPE P
```

Ln 1, Col 1 INS

r.mfilter

Raster file matrix filter.

Input raster map: raster

Output raster map: raster

ASCII filter file: file

Number of times the filter is applied [1]:

Title of the output raster map:

☐ Run quietly.

☐ Apply filter only to zero data values.

r.mfilter

High Pass Modulation Fusion

$$DN_{MS}^h = DN_{MS}^l + (DN_{PAN}^h - DN_{PAN}^l) \frac{DN_{MS}^l}{DN_{PAN}^l}$$

where $DN_{PAN}^l = DN_{PAN}^h * h_0$ and h_0 is the same LP filter as used in the HPF method.

r.hpm

Raster file matrix filter.

Input multispectral raster band1: raster

Input multispectral raster band2: raster

Input multispectral raster band3: raster

Input multispectral raster band4: raster

Input multispectral raster band5: raster

Input multispectral raster band6: raster

Input multispectral raster band7: raster

Input high resolution map: raster

Output fused raster map: raster

ASCII low pass filter file: file

Number of times the filter is applied [1]:

☐ Run quietly.

r.hpm

low_pass_filter (~/Filters) - gedit

File Edit View Search Tools Documents Help

New Open Save Print... Undo Redo Cut Copy Paste Find Replace

low_pass_filter x

```
TITLE 5x5 Low Pass
MATRIX 5
1 1 1 1 1
1 1 1 1 1
1 1 1 1 1
1 1 1 1 1
1 1 1 1 1
DIVISOR 25
TYPE P
```

Ln 1, Col 1 INS

PCA Fusion

i.pca

Principal components analysis (pca) prog

Input raster maps (name[,name,...]):

raster

Output raster map:

raster

Rescaling range output (min,max) [1,255]:

i.pca **Run**

i.reverse pca

Principal components analysis (pca) program for i

Input PC raster maps (name[,name,...]):

raster

Input high resolution raster map:

raster

Output fused raster map:

raster

{i.reverse pca} **Run**

Fourier Transformation Fusion

$$MS_i^H = FT^{-1} \{ LPF \{ FT(MS_i^L) \} + HPF \{ FT(PAN) \} \}$$

i.fft

Fast Fourier Transform (FFT) for image processing.

Input raster map on which the FFT is run:
 raster

Output real part arrays stored as raster map:
 raster

Output imaginary part arrays stored as raster map:
 raster

Range of values used during FFT:

i.fft **Run**

i.ifft

Inverse Fast Fourier Transform (IFFT) for image processing.

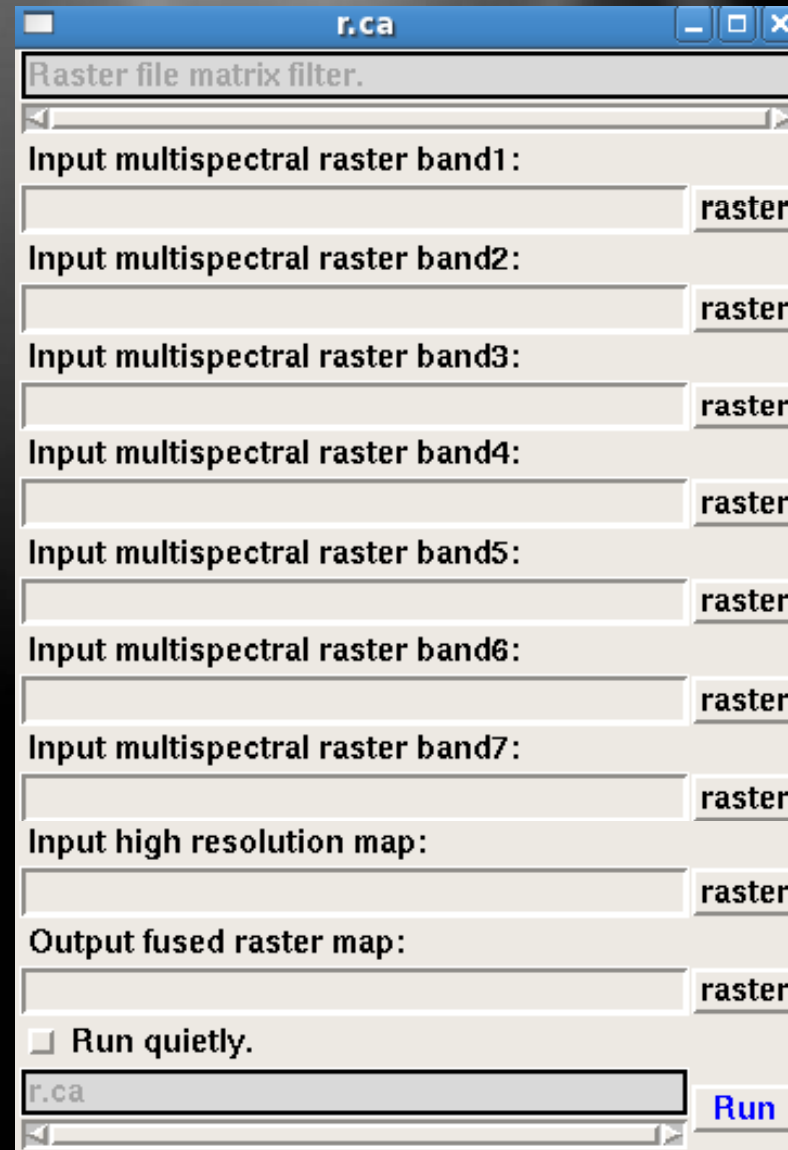
Input raster map for IFFT, real part:
 raster

Input raster map for IFFT, imaginary part:
 raster

Output raster after IFFT:
 raster

i.ifft **Run**

Correspondence Analysis Fusion



The image shows a software dialog box titled "r.ca" with standard window controls (minimize, maximize, close). The dialog is used for "Raster file matrix filter." and contains the following fields and controls:

- Input multispectral raster band1:** A text input field followed by a "raster" button.
- Input multispectral raster band2:** A text input field followed by a "raster" button.
- Input multispectral raster band3:** A text input field followed by a "raster" button.
- Input multispectral raster band4:** A text input field followed by a "raster" button.
- Input multispectral raster band5:** A text input field followed by a "raster" button.
- Input multispectral raster band6:** A text input field followed by a "raster" button.
- Input multispectral raster band7:** A text input field followed by a "raster" button.
- Input high resolution map:** A text input field followed by a "raster" button.
- Output fused raster map:** A text input field followed by a "raster" button.
- ☐ **Run quietly.**
- A text field at the bottom containing "r.ca" with a scroll bar.
- A blue **Run** button at the bottom right.

Gram Schmidt Fusion

r.gs

Raster file matrix filter.

Input multispectral raster band1: raster

Enter current wavelength value (average) for band1:

Input multispectral raster band2: raster

Enter current wavelength value (average) for band2:

Input multispectral raster band3: raster

Enter current wavelength value (average) for band3:

Input multispectral raster band4: raster

Enter current wavelength value (average) for band4:

Input multispectral raster band5: raster

Enter current wavelength value (average) for band5:

Input multispectral raster band6: raster

Enter current wavelength value (average) for band6:

Input multispectral raster band7: raster

Enter current wavelength value (average) for band7:

Input high resolution PAN band: raster

Enter current wavelength value (average) for PAN:

Output fused raster map: raster

☐ Run quietly.

r.gs

$$B_{wt} = \int_{0.4}^{0.5} OT_B(\lambda) * SR_B(\lambda) * SR_{PAN}(\lambda) d\lambda$$

$$G_{wt} = \int_{0.5}^{0.6} OT_G(\lambda) * SR_G(\lambda) * SR_{PAN}(\lambda) d\lambda$$

$$R_{wt} = \int_{0.6}^{0.7} OT_R(\lambda) * SR_R(\lambda) * SR_{PAN}(\lambda) d\lambda$$

$$NIR_{wt} = \int_{0.7}^{0.8} OT_{NIR}(\lambda) * SR_{NIR}(\lambda) * SR_{PAN}(\lambda) d\lambda$$

where OT is the optical transmittance, SR is the spectral response and λ is the wavelength.

CN Spectral Fusion

r.cns

Raster file matrix filter.

Input multispectral raster band1: raster

Input multispectral raster band2: raster

Input multispectral raster band3: raster

Input multispectral raster band4: raster

Input multispectral raster band5: raster

Input multispectral raster band6: raster

Input multispectral raster band7: raster

Input high resolution PAN band: raster

Output fused raster map: raster

☐ Run quietly.

r.cns **Run**

$$MS_i^H = \frac{4(MS_i^L) \cdot PAN}{(\sum MS_i^L) + 4} - 1$$

where MS_i^H are the fused images, MS_i^L are the LR MS bands, PAN is a HR panchromatic band, and i = band 1 to band 7.

Luminance Chrominance Fusion

$$\begin{pmatrix} Y \\ I \\ Q \end{pmatrix} = \begin{pmatrix} 0.299 & 0.587 & 0.114 \\ 0.596 & -0.274 & -0.322 \\ 0.211 & -0.523 & 0.312 \end{pmatrix} \begin{pmatrix} R \\ G \\ B \end{pmatrix}$$
$$\begin{pmatrix} R \\ G \\ B \end{pmatrix} = \begin{pmatrix} 1.000 & 0.996 & 0.621 \\ 1.000 & -0.272 & -0.647 \\ 1.000 & -1.106 & -1.703 \end{pmatrix} \begin{pmatrix} Y \\ I \\ Q \end{pmatrix}$$

The screenshot shows a software window titled 'r.lc' with a standard Windows-style title bar (minimize, maximize, close buttons). The interface is designed for processing raster data. It features a 'Raster file matrix filter.' dropdown menu at the top. Below this, there are four input fields, each followed by a 'raster' button: 'Input multispectral raster band1:', 'Input multispectral raster band2:', 'Input multispectral raster band3:', and 'Input high resolution PAN band:'. An 'Output fused raster map:' field with a 'raster' button is located below these. A checkbox labeled 'Run quietly.' is positioned above the bottom section. The bottom section includes a file path input field containing 'r.lc' and a blue 'Run' button. The background of the slide features abstract green and blue light streaks.

GRDSS Map calculator

mapcalculator.sh — □ ×

Calculates a new raster map from raster maps

☐ Show short help
☐ Help: man r.mapcalc
☐ Expert mode

A:
 raster

B:
 raster

C:
 raster

D:
 raster

E:
 raster

F:
 raster

Formula: outfile = (e.g.: A-B or A*C+B)

Resulting output map (required):
 raster

☐ Don't overwrite existing raster map

mapcalculator.sh Run

mapcalculator.sh — □ ×

Calculates a new raster map from raster maps

☐ Show short help
☐ Help: man r.mapcalc
☒ Expert mode

A:
 raster

B:
 raster

C:
 raster

D:
 raster

E:
 raster

F:
 raster

Formula: outfile = (e.g.: A-B or A*C+B)

Resulting output map (required):
 raster

☐ Don't overwrite existing raster map

mapcalculator.sh expert=expert Stop

r.mapcalc — □ ×

Enter expressions, "end" when done.
mapcalc>

Results of different fusion techniques

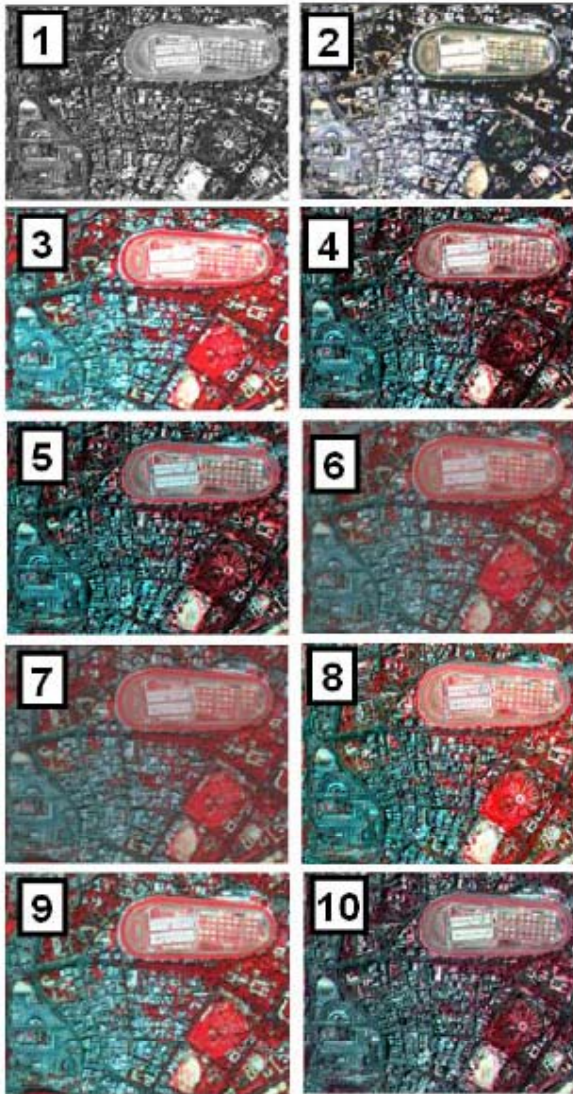


Figure 1. Original PAN image (1), original LR MS image (B-G-R) resampled at 1 m pixel size (2), original LR MS image (G-R-NIR) resampled at 1 m pixel size (3), Fusion through IHS (4), BT (5), HPM (6), PCA (8), FT (9) and CA (10).

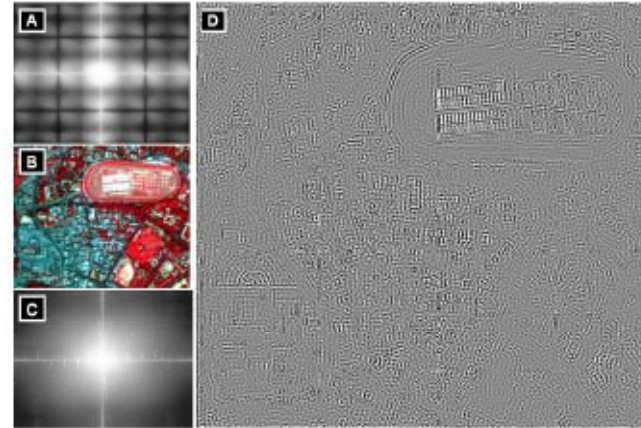


Figure 2. (A) FT on MS (B) Inverse FT on MS, (C) FT on PAN, (D) Inverse FT on PAN.

Results of different fusion techniques

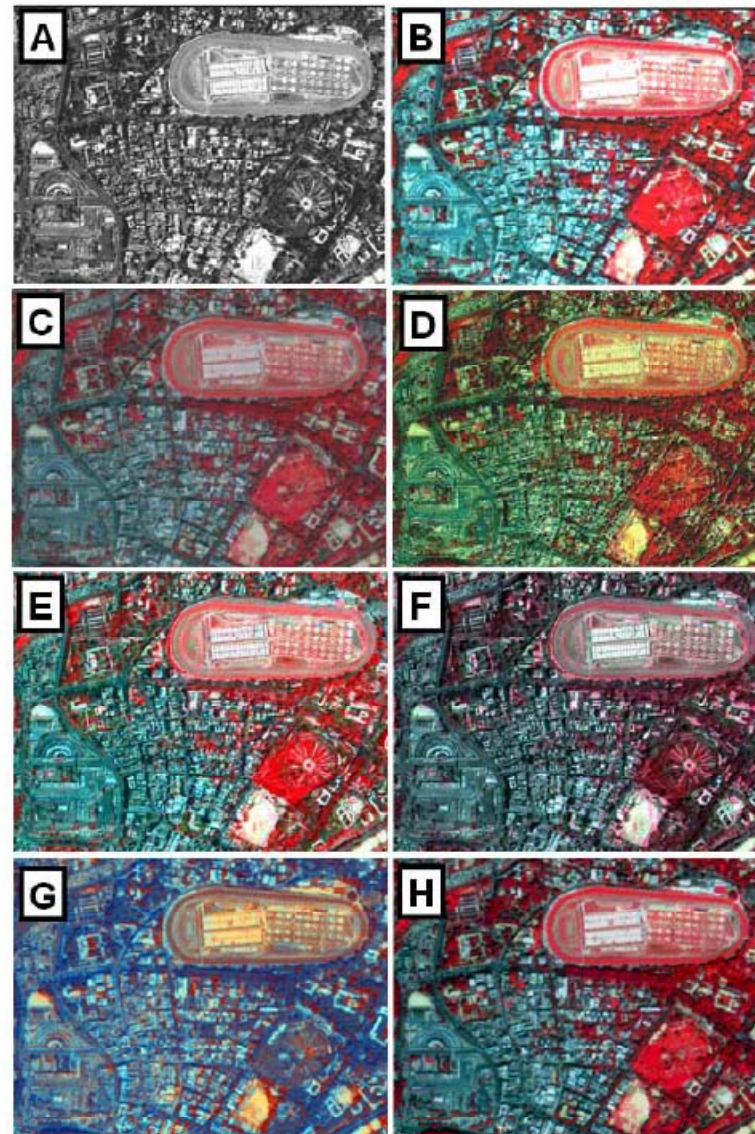


Figure 1. (A) Original PAN image, (B) Original low resolution MS image (G-R-NIR) resampled at 1 m pixel size, fusion results from (C) ATW, (D) MRAIM, (E) GS, (F) CNS, (G) LC and (H) HPF.



Validation

$$Q = \frac{\sigma_{AB}}{\sigma_A \sigma_B} \cdot \frac{2\mu_A \mu_B}{\mu_A^2 + \mu_B^2} \cdot \frac{2\sigma_A \sigma_B}{\sigma_A^2 + \sigma_B^2}$$

CC Closeness Similarity

TABLE 1. UIQI OF FUSED AND ORIGINAL IMAGE

	Blue	Green	Red	NIR
HIS	-	0.17	0.27	0.12
BT	-	0.89	0.97	0.54
HPF	0.85	0.94	0.96	0.98
HPM	0.83	0.94	0.97	0.95
PCA	0.68	0.63	0.63	0.46
FT	0.43	0.22	0.73	0.81
CA	0.27	-0.01	0.06	-0.00

TABLE 2. CORRELATION BETWEEN IKONOS HR PAN AND CORRESPONDING LR PAN IMAGES FROM DIFFERENT METHODS

IHS	BT	HPF	HPM	PCA	FT	CA
0.32	0.32	0.95	0.95	0.32	-	0.27

p value for all CC = $2.2e^{-16}$

Both IHS and BT are limited to 3 bands (G, R and NIR).
IHS and BT use the same low resolution PAN image.
HPF and HPM use the same low resolution PAN image.
There is no generation of low resolution PAN in FT.

TABLE I.
UIQI MEASUREMENTS OF THE SIMILARITY BETWEEN ORIGINAL AND THE FUSED IMAGES OBTAINED BY VARIOUS METHODS

	Blue	Green	Red	NIR
ATW	0.83	0.92	0.95	0.99
MRAIM	0.81	0.89	0.91	0.93
GS	0.49	0.44	0.46	0.43
CNS	0.12	0.29	0.43	0.43
LC	-	0.12	0.92	0.61
HPF	0.93	0.94	0.93	0.94

TABLE II.
CORRELATION BETWEEN THE IKONOS HR PAN IMAGE AND THE CORRESPONDING LR PAN IMAGE BY DIFFERENT METHODS

ATW	MRAIM	GS	CNS	LC	HPF
0.85	0.80	0.65	-	0.71	0.86

p value for all CC = $2.2e^{-16}$

LC is limited to three bands (G-R-NIR combination).
PAN image was used in CNS without any transformation.

TABLE III.
EVALUATION OF ORIGINAL AND FUSED NIR BAND BY DIFFERENT METHODS

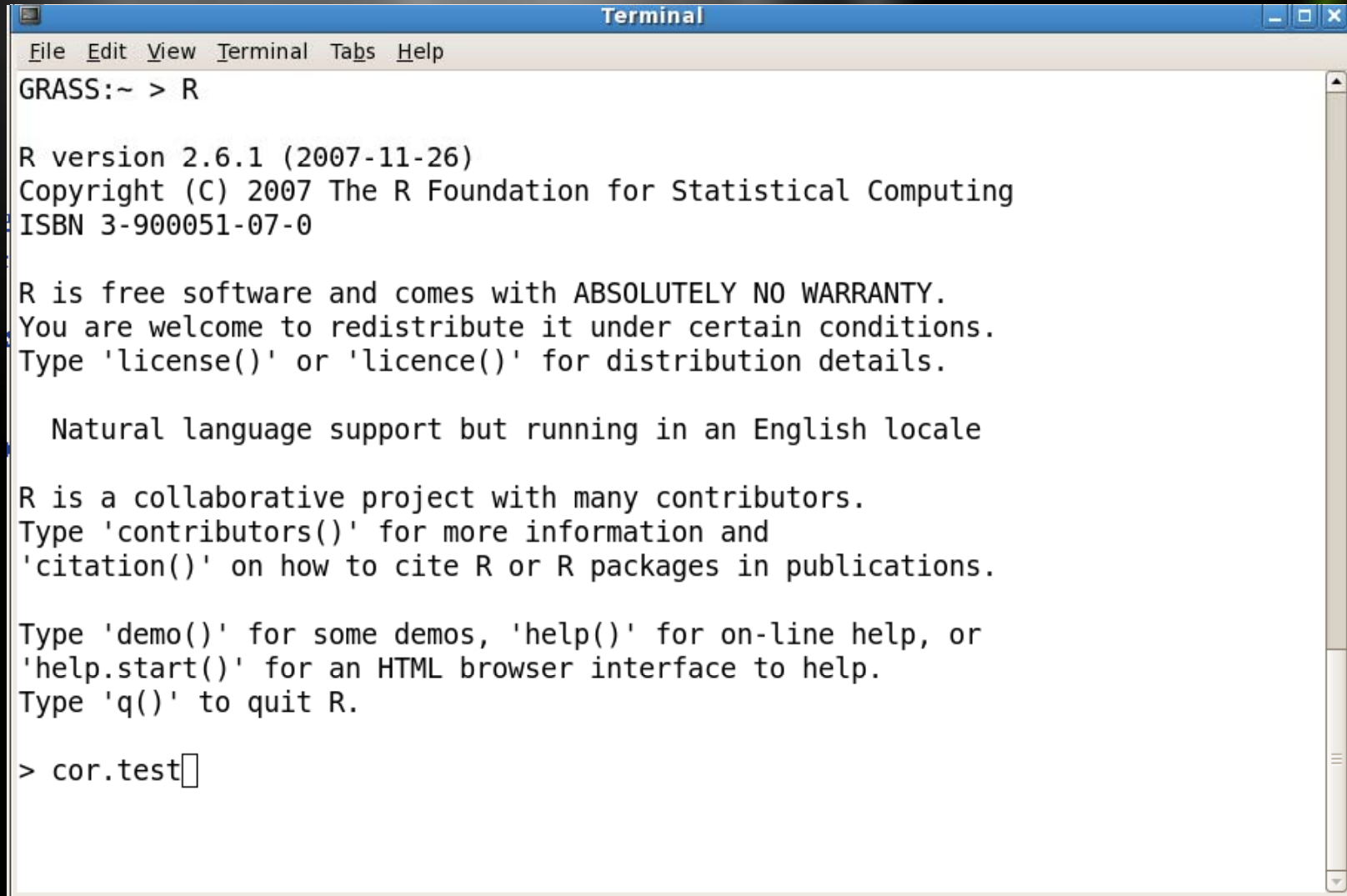
	UIQI	CC	Min	Max	Sd
Original NIR	1	1	195	811	87
Fused NIR (ATW)	0.99	0.98	125	867	88.5
Fused NIR (HPF)	0.94	0.99	152	650	68.1

GRDSS: Interface with R

- The R/GRASS interface substantially improves the geospatial analysis capabilities of GRASS.
- For the integration of R with GRASS, you need to run R from the GRASS shell environment.
- The interface dynamically loads compiled GIS library functions into the R environment.
- GRASS>R> R CMD INSTALL spgrass6_0.3-7.tar.gz
- For more details see:

OPEN SOURCE GIS
A GRASS GIS Approach
Third Edition
Markus Neteler & Helena Mitasova
Springer

GRDSS: Interface with R

A screenshot of a terminal window titled "Terminal". The window has a menu bar with "File", "Edit", "View", "Terminal", "Tabs", and "Help". The terminal content shows the command "GRASS:~ > R" being executed. The output is the standard R startup message, including the version (2.6.1), copyright (2007), and various help instructions. The prompt "> cor.test" is visible at the bottom.

```
GRASS:~ > R

R version 2.6.1 (2007-11-26)
Copyright (C) 2007 The R Foundation for Statistical Computing
ISBN 3-900051-07-0

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

    Natural language support but running in an English locale

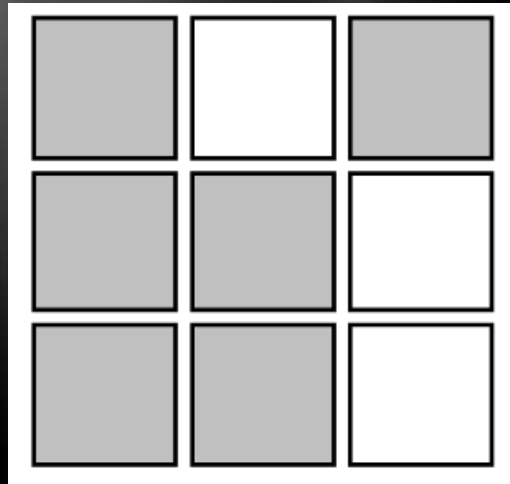
R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> cor.test
```

Forest fragmentation

- Forest fragmentation is the process whereby a large, continuous area of forest is both reduced in area and divided into two or more fragments (K. J. Ritters et al., 2000).
- For calculating forest fragmentation and its occurrence as adjacent pixels, fixed-area windows surrounding each forest pixel is used.



Pf equals $6/9=0.67$

Total number of adjacent pixel pairs is 12, and of these, 11 pairs include at least one forested pixel. Five of those 11 pairs are forest-forest pairs. Pff equals $5/11 = 0.45$

Forest fragmentation

The six fragmentation model that identifies six categories are:

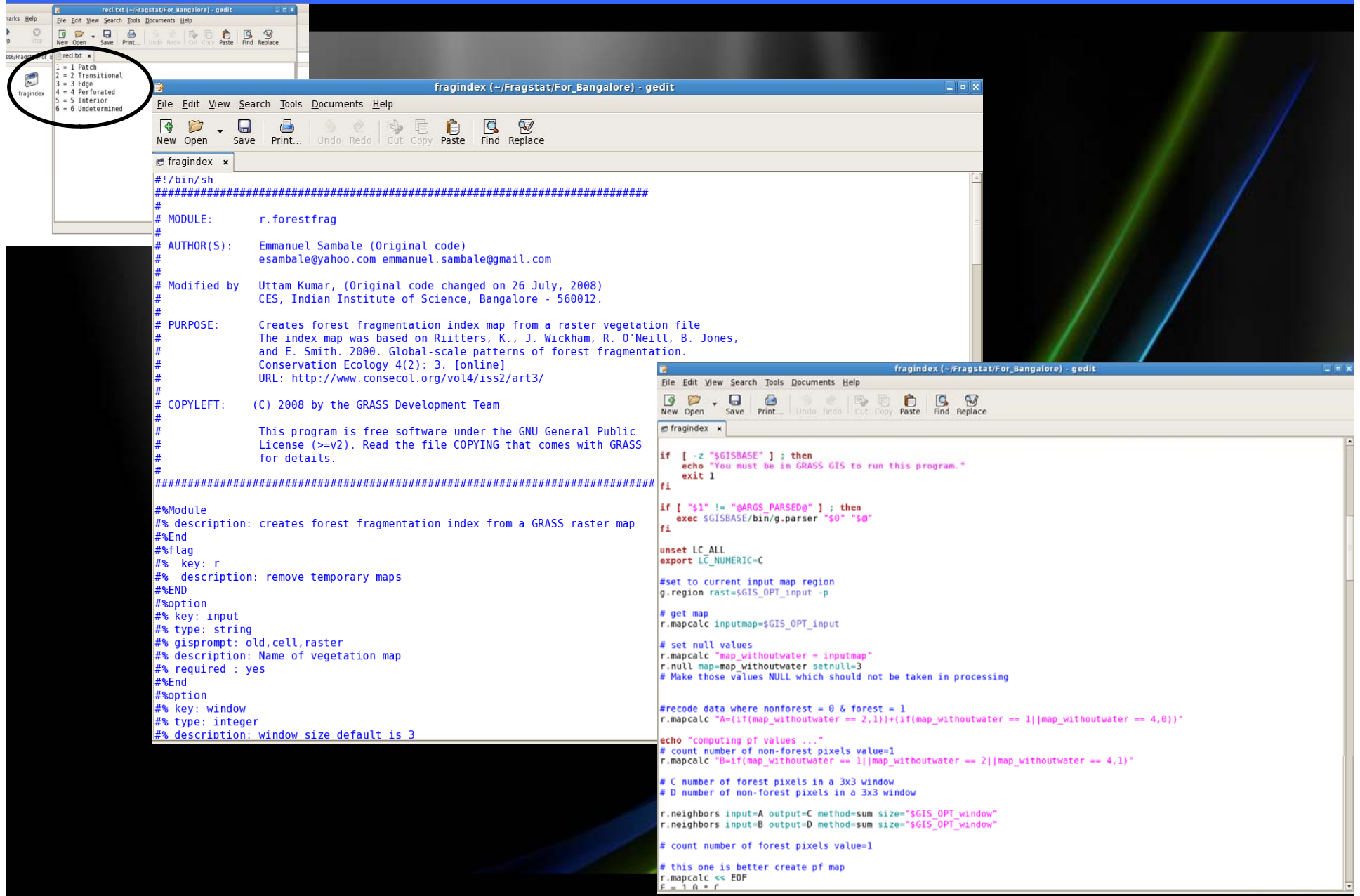
- | | |
|------------------|---------------------------------|
| (1) Interior | (Pf = 1.0) |
| (2) Patch | (Pf < 0.4) |
| (3) Transitional | (0.4 < Pf < 0.6) |
| (4) Edge | (Pf > 0.6 and Pf - Pff > 0) |
| (5) Perforated | (Pf > 0.6 and Pf - Pff < 0) and |
| (6) Undetermined | (Pf > 0.6 and Pf = Pff) |

$$TFP = \frac{\text{total forest area}}{\text{total non - water area}}$$

$$FC = \frac{\text{weighted forest area}}{\text{total forest area}} * \frac{\text{area of largest interior forest patch}}{\text{total forest area}}$$

$$WFA = (1.0 * \text{interior}) + (0.8 * (\text{perforated} + \text{edge} + \text{undertermined}) + (0.5 + \text{transitiojnal}) + (0.2 * \text{patch}))$$

Forest fragmentation



```
rec1.txt (~Fragstat/For_Bangalore) - gedit
1 = 1 Patch
2 = 2 Transitional
3 = 3 Edge
4 = 4 Perforated
5 = 5 Interior
6 = 6 Undetermined

fragindex (~Fragstat/For_Bangalore) - gedit

#!/bin/sh
#####
# MODULE:      r.forestrag
# AUTHOR(S):   Emmanuel Sambaale (Original code)
#              esambaale@yahoo.com emmanuel.sambaale@gmail.com
#
# Modified by  Uttam Kumar, (Original code changed on 26 July, 2008)
#              CES, Indian Institute of Science, Bangalore - 560012.
#
# PURPOSE:     Creates forest fragmentation index map from a raster vegetation file
#              The index map was based on Riitters, K., J. Wickham, R. O'Neill, B. Jones,
#              and E. Smith. 2000. Global-scale patterns of forest fragmentation.
#              Conservation Ecology 4(2): 3. [online]
#              URL: http://www.consecol.org/vol4/iss2/art3/
#
# COPYRIGHT:   (C) 2008 by the GRASS Development Team
#
#              This program is free software under the GNU General Public
#              License (>=v2). Read the file COPYING that comes with GRASS
#              for details.
#####

%%Module
%% description: creates forest fragmentation index from a GRASS raster map
%%End
%%flag
%% key: r
%% description: remove temporary maps
%%END
%%option
%% key: input
%% type: string
%% gisprompt: old,cell,raster
%% description: Name of vegetation map
%% required : yes
%%End
%%option
%% key: window
%% type: integer
%% description: window size default is 3

if [ -z "$GISBASE" ]; then
    echo "You must be in GRASS GIS to run this program."
    exit 1
fi

if [ "$1" != "$ARGS_PARSED0" ]; then
    exec $GISBASE/bin/g.parser "$0" "$@"
fi

unset LC_ALL
export LC_NUMERIC=C

#set to current input map region
g.region rast=$GIS_OPT_input -p

# get map
r.mapcalc inputmap=$GIS_OPT_input

# set null values
r.mapcalc "map_withoutwater = inputmap"
r.null map=map_withoutwater setnull=3
# Make those values NULL which should not be taken in processing

#recode data where nonforest = 0 & forest = 1
r.mapcalc "A=(if(map_withoutwater == 2,1)+(if(map_withoutwater == 1||map_withoutwater == 4,0)))"

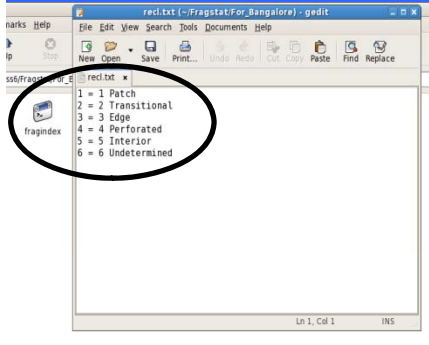
echo "computing pf values ..."
# count number of non-forest pixels value=1
r.mapcalc "B=if(map_withoutwater == 1||map_withoutwater == 2||map_withoutwater == 4,1)"

# C number of forest pixels in a 3x3 window
# D number of non-forest pixels in a 3x3 window
r.neighbors input=A output=C method=sum size="$GIS_OPT_window"
r.neighbors input=B output=D method=sum size="$GIS_OPT_window"

# count number of forest pixels value=1

# this one is better create pf map
r.mapcalc << EOF
F = 1.0 * C
```

Forest fragmentation



```
Terminal
File Edit View Terminal Tabs Help

Welcome to GRASS 5.0.3 (October 2003)

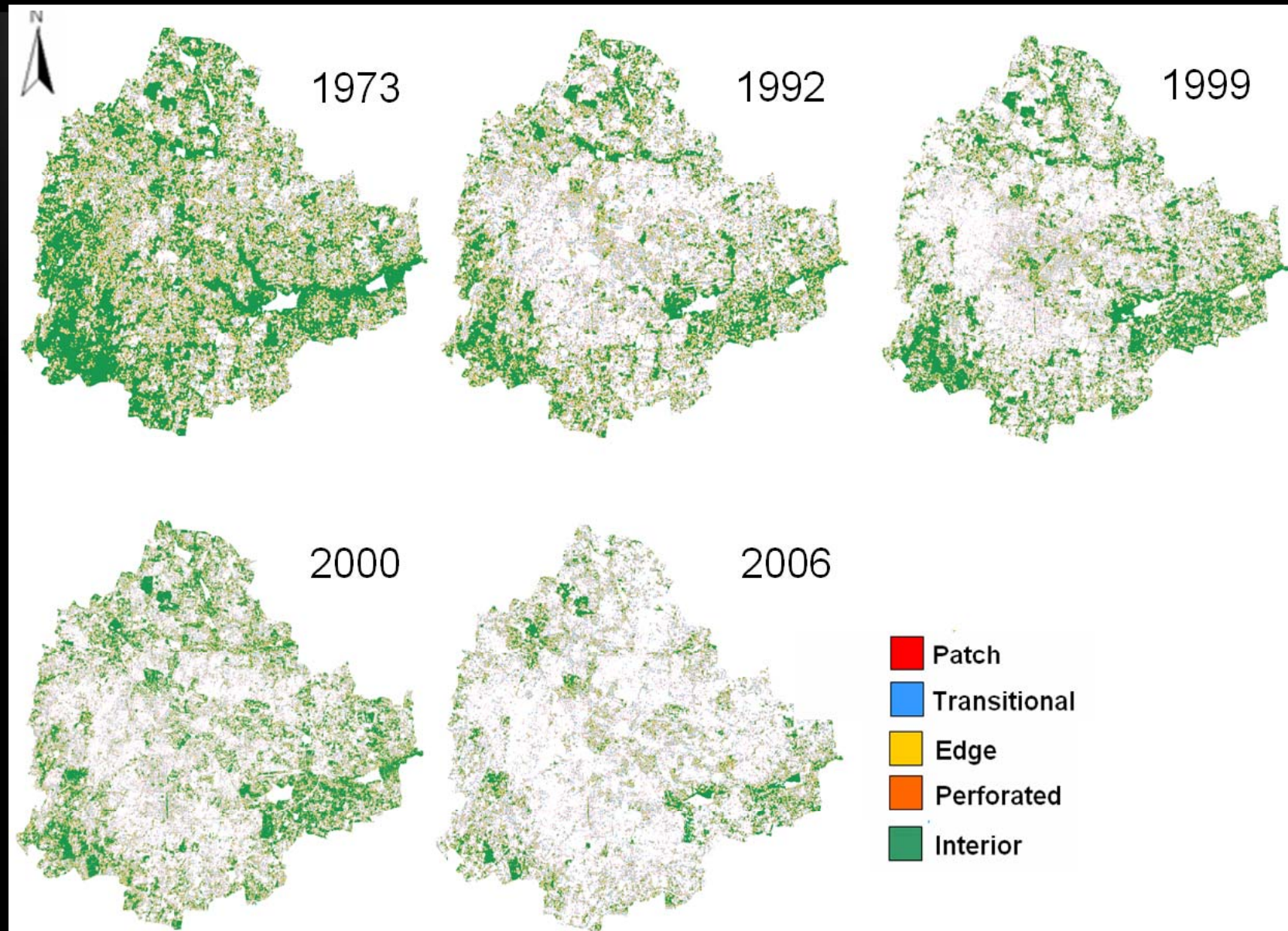
Geographic Resources Analysis Support System (GRASS) is Copyright,
1999-2002 by the GRASS Development Team, and licensed under terms of the
GNU General Public License (GPL).

This GRASS 5.0.3 release is coordinated and produced by the
GRASS Development Team headquartered at ITC-irst (Trento, Italy) with
worldwide support and further development sites located at Baylor
University and the University of Illinois (U.S.A.).

This program is distributed in the hope that it will be useful, but
WITHOUT ANY WARRANTY; without even the implied warranty of
MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU
General Public License for more details.

This version running thru the Bash Shell (/bin/bash)
Help is available with the command:      g.help
See the licence terms with:              g.version -c
If required, restart the graphical user interface with: tcltkgrass&
When ready to quit enter:                exit
GRASS:~ >
GRASS:~ >
GRASS:~ > ./fragindex_Mandhala -r input=MSS_classify_final window=3
```

Forest fragmentation 1973 - 2006



Forest fragmentation

Forest Fragmentation Categories	1973		1992		1999		2000		2006	
	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%
Patch	1120	2.45	1950	6.34	1788.6	5.91	1944	6.47	1810	9.57
Transitional	3789	8.28	4259	13.84	3816	12.62	3999	13.31	3956	20.92
Edge	14717	32.16	10709	34.81	9516	31.46	10593	35.25	6050	31.99
Perforated	1453	3.18	1447	4.70	1410	4.66	1219	4.06	1859	9.83
Interior	24675	53.93	12401	40.31	13715	45.35	12291	40.91	5236	27.69
Total	45756	100	30766	100	30244	100	30047	100	18909	100

Total forest proportion and forest continuity

State of forest fragmentation index	1973	1992	1999	2000	2006
TFP	0.71	0.48	0.47	0.46	0.29
FC	0.45	0.30	0.34	0.30	0.19

Urban fragmentation

- The urban growth model (D. L. Civco et al., 2002) uses multi-dates urban (developed) and non-urban (non-developed) classes.
- Interior - all pixels in a 3 x 3 window are non-developed.
- Perforated - when $> 60\%$ and $< 100\%$ of pixels in a 3 x 3 window are non-developed.
- Patch - $< 60\%$ of pixels in a 3 x 3 window are non-developed.

Urban fragmentation

Significant Change Classes	Type of Growth
Patch to Developed	Infill Growth
Perforated to Developed	Expansion Growth
Interior to Developed	Outlying Growth: Isolated, Linear Branching, Clustered Branching Growth

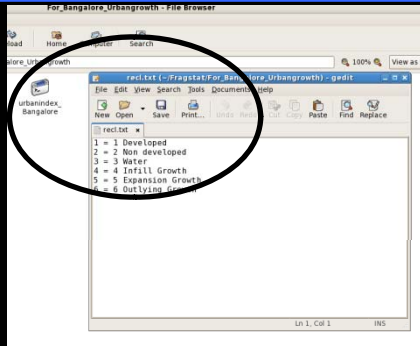
Infill – development surrounded by existing developed land.

Expansion - spreading out of urban LC from existing developed land.

Outlying growth - interior pixel that changes to developed.

- An isolated growth - new, small area of construction surrounded by non-urban land and some distance from other developed areas.
- A linear branching growth - is a road, corridor, or linear development.
- A clustered branching - new, large and dense development in a previously undeveloped area.

Urban fragmentation



```
urbanindex_Bangalore (~/.Fragstat/For_Bangalore_Urbangrowth) - gedit
File Edit View Search Tools Documents Help
New Open Save Print... Undo Redo Cut Copy Paste Find Replace

urbanindex_Bangalore x
# Conservation Ecology 4(2): 3. [online]
# URL: http://www.consecol.org/vol4/iss2/art3/
# COPYRIGHT: (C) 2008 by the GRASS Development Team
#
# This program is free software under the GNU General Public
# License (>=v2). Read the file COPYING that comes with GRASS
# for details.
#####

%%Module
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%% key: r
%% description: remove temporary maps
%%END
%%option
%% key: input
%% type: string
%% gisprompt: old,cell,raster
%% description: Name of vegetation map
%% required : yes
%%End
%%option
%% key: window
%% type: integer
%% description: window size default is 3
%% answer : 3
%% required : yes
%%END

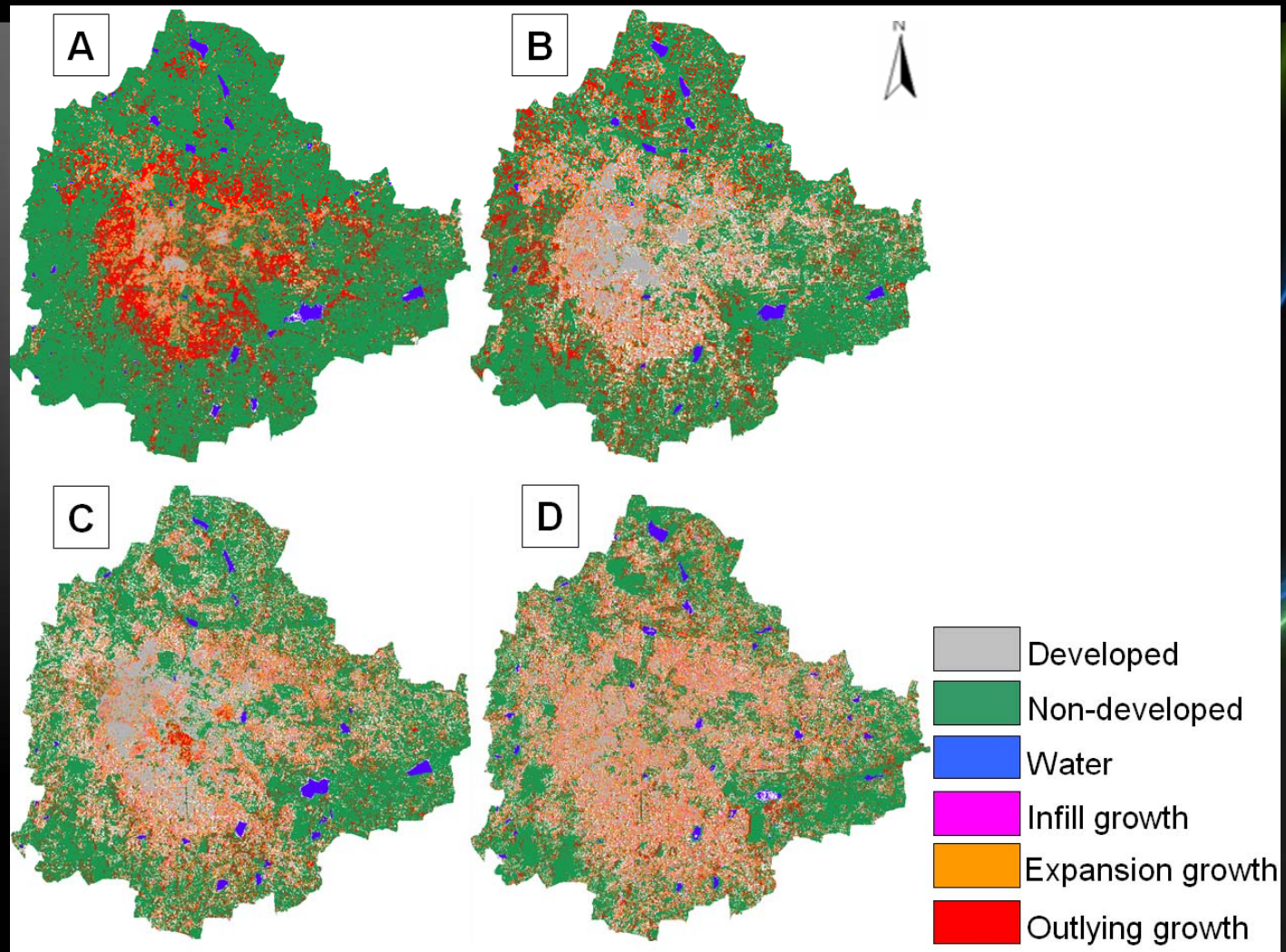
if [ -z "$GISBASE" ] ; then
    echo "You must be in GRASS GIS to run this program."
    exit 1
fi

if [ "$1" != "@ARGS_PARSED@" ] ; then
    exec $GISBASE/bin/g.parser "$@" "$@"
fi

unset LC_ALL
```

Ln 1, Col 1 INS

Urban fragmentation



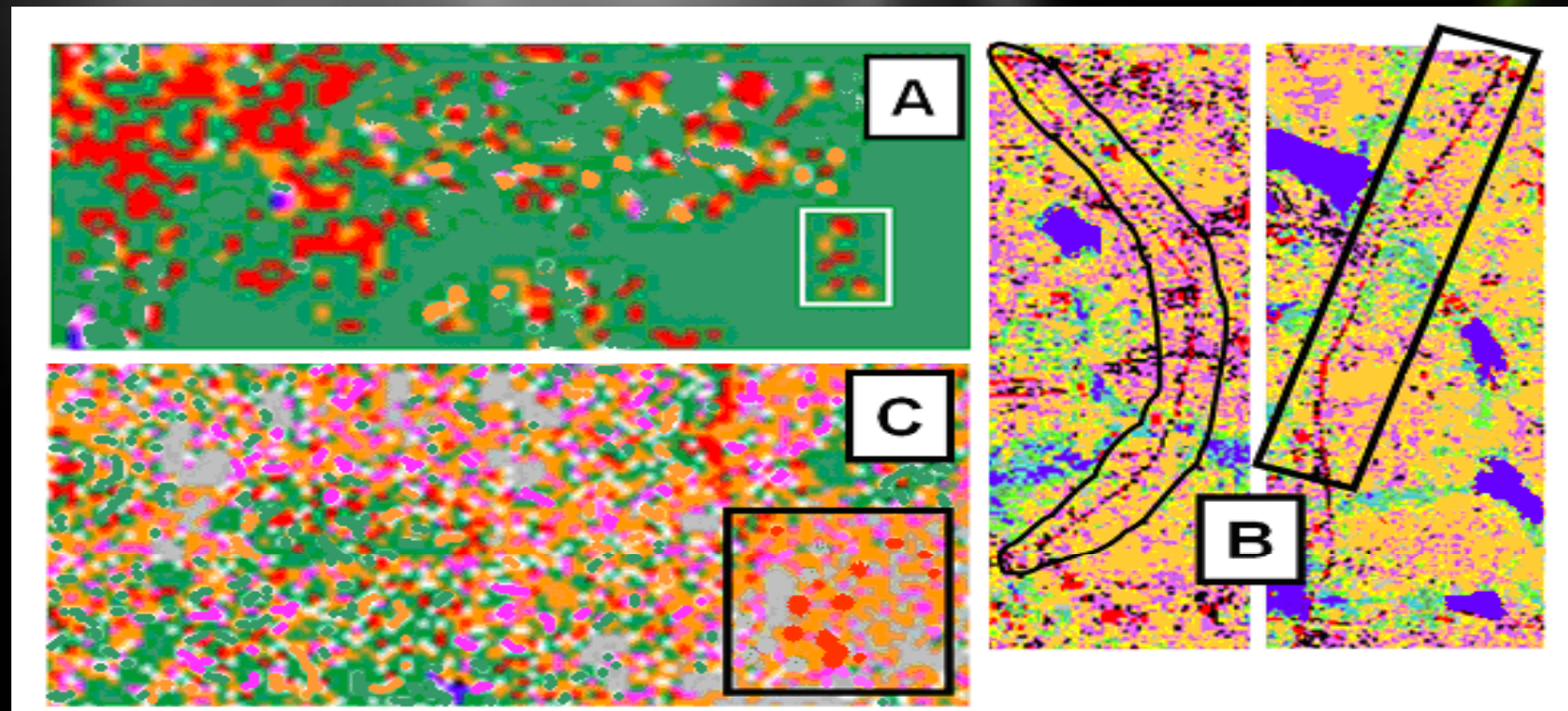
Urban growth map (A) 1973 to 1992, (B) 1992 to 1999, (C) 1999 to 2000, (D) 2000 to 2006.

Urban fragmentation

Changes in urban growth types from 1973 to 2006

Urban Growth Type	1973 - 1992		1992 - 1999		1999 - 2000		2000 - 2006	
	Ha	%	Ha	%	Ha	%	Ha	%
Developed	6889	1.01	3818	5.60	2876	4.22	32380	4.74
Non-developed	48529	71.3	44034	64.6	42610	62.5	37922	55.54
Water	905	1.33	692	1.01	1434	2.10	952	1.39
Infill	720	1.06	2146	3.15	3088	4.53	4232	6.20
Expansion	5720	8.40	10078	14.8	13110	19.2	16412	24.04
Outlying	11520	16.9	7453	10.9	5054	7.41	5526	8.09
Total	68082	100	68220	100	68172	100	68282	100

Urban fragmentation



typical urbanizing growth patterns

- (A) isolated growth,
- (B) linear branching (road/corridor),
- (C) clustered growth.

Urban fragmentation

- Forest fragmentation model shows that Interior forest which was present in the city up to 54 % (in 1973) has come down to 28 % in 2006.
- Urban growth characterised by developed, infill, expansion and outlying types evidently illustrate the phenomenon of urbanising Greater Bangalore.

Landscape analysis with r.li

Landscape analysis is the study of the variation in landscape over multiple spatial and temporal scales (IALE, 1998).

The r.li program in GRASS is written for landscape analysis (Baker, 1992; Baker, 2001).

IALE, 1998. IALE mission statement. IALE Bulletin 16(1), 1.

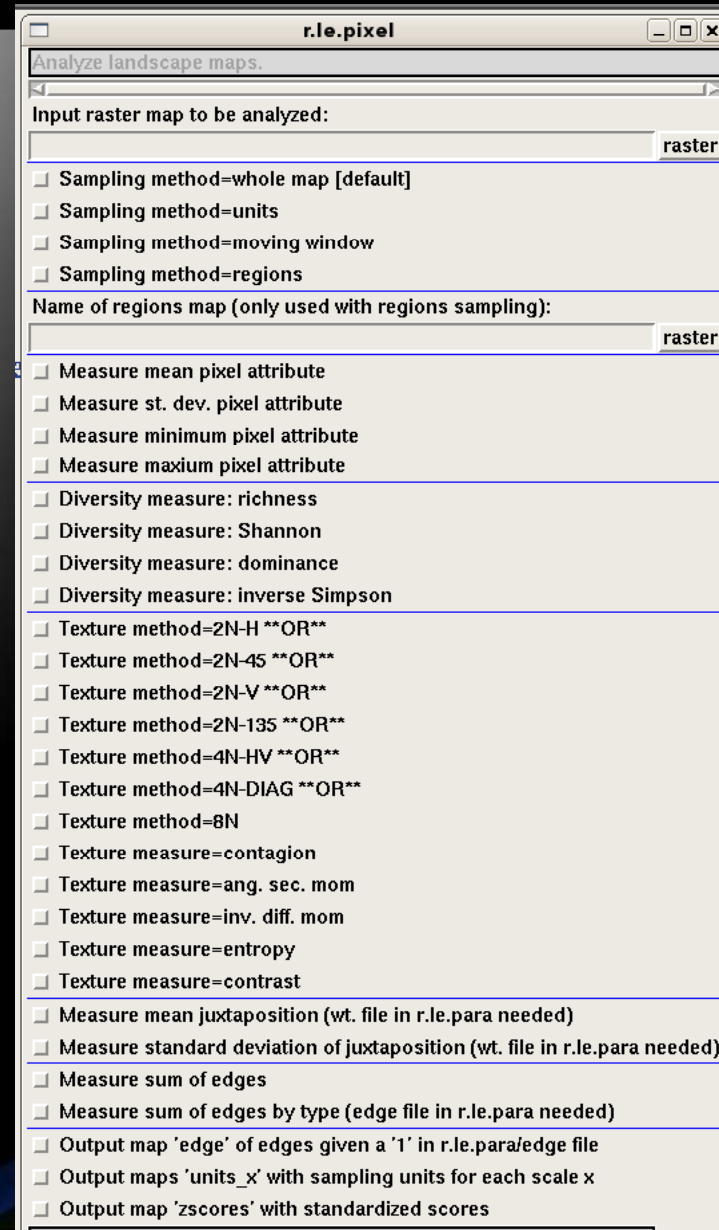
Baker, W.L., Cai, Y., 1992. The r.li programs for multiscale analysis of landscape structure using the GRASS geographical information system. Landscape Ecology 7, 291–302.

Baker, W.L., 2001. The r.li programs: a set of GRASS programs for the quantitative analysis of landscape structure. Department of Geography. University of Wyoming.

Landscape analysis with r.li



Landscape analysis with r.li



Landscape analysis with r.li

r.li.patch

Analyze landscape patches.

Input raster map to be analyzed:

Sampling method (w=whole map [default], u=units, m=moving window, r=region)

Name of regions map (only used with regions sampling):

- ☐ Measure mean pixel attribute
- ☐ Measure st. dev. pixel attribute
- ☐ Measure mean patch attribute
- ☐ Measure st. dev. patch attribute
- ☐ Measure cover by qp
- ☐ Measure density by qp
- ☐ Measure total density
- ☐ Measure effective mesh number
- ☐ Measure mean patch size
- ☐ Measure st. dev. patch size
- ☐ Measure mean patch size by qp
- ☐ Measure st. dev. patch size by qp
- ☐ Measure no. by size class
- ☐ Measure no. by size class by qp
- ☐ Measure effective mesh size

Edge width in pixels (integer) for use with core size measures

- ☐ Measure mean core size
- ☐ Measure st. dev. core size
- ☐ Measure mean edge size
- ☐ Measure st. dev. edge size
- ☐ Measure mean core size by qp
- ☐ Measure st. dev. core size by qp
- ☐ Measure mean edge size by qp
- ☐ Measure st. dev. edge size by qp
- ☐ Measure no. by size class
- ☐ Measure no. by size class by qp

Method for shape measures (m1=perim./area, m2=core perim./area, m3=rel. circum.circle)

- ☐ Measure mean patch shape
- ☐ Measure st. dev. patch shape
- ☐ Measure mean patch shape by qp
- ☐ Measure st. dev. patch shape by qp
- ☐ Measure no. by shape class
- ☐ Measure no. by shape class by qp
- ☐ Measure mean twist number
- ☐ Measure st. dev. twist number
- ☐ Measure mean omega index
- ☐ Measure st. dev. omega index
- ☐ Measure sum of perimeters
- ☐ Measure mean perimeters.
- ☐ Measure st. dev. perimeters
- ☐ Measure sum of perimeters by qp
- ☐ Measure mean perimeters by qp
- ☐ Measure st. dev. perimeters by qp

Name of output file for patch measures

- ☐ Output map 'interior' with patch cores for core measures
- ☐ Output map 'num' with patch numbers
- ☐ Include sampling area boundary as perimeter
- ☐ Use 4 neighbor tracing instead of 8 neighbor

r.li.trace

Displays boundaries of patches, show how bou

Input raster map to be analyzed:

Output file to store patch data:

- ☐ Output map 'num' with patch numbers
- ☐ sampling
- ☐ Use 4 neighbor tracing instead of 8 neighbor

Conclusions

- Addition of band extraction, image fusion, forest/urban fragmentation modules and landscape analysis tool
- We advocate more wide publicity and use of FOSS GIS.
- We recommend that FOSS community considers directing their efforts towards a common software development effort within FOS GIS, and establish specific user and developer forums.
- We suggest to have some ideal location or repository for such developmental activities with links to special interest groups who could concentrate on specific research related plug-ins.
- If such unified software development and research efforts could be initiated then we expect great potential to accelerate FOSS4G research in India.

Future directions: Road map to FOSS4G

- Integration of GRDSS with QGIS
- Modules for Hyperspectral Image Processing
- Easy interface of GRASS with R
- Modules for SAR image processing
- Addition of advanced pattern recognition techniques
- Inclusion of OBIA techniques



