Spatial characteristics of vegetation index map in urban area derived by variogram analysis

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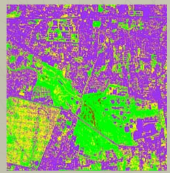
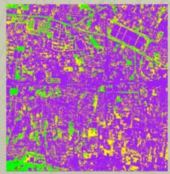
Vegetation analysis by satellite data(QuickBird)

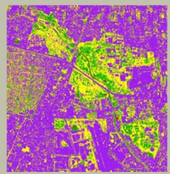
- NDVI(Vegetation Index) colored map derived from satellite data
- Richly vs. poorly vegetated areas (boxed areas)
- Attempt to extract vegetation features of urban area in Tokyo by a variogram analysis



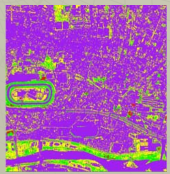
Area 'Vegetation1' (2003/9/3)



Area 'Urban1' (2003/9/3)



Area 'Vegetation2' (2003/4/9)



Area 'Urban2' (2003/4/9)

NDVI
~ 0.6
0.6 ~ 0.4
0.4 ~ 0.2
0.2 ~

$$NDVI = \frac{\rho_{NIR} - \rho_{V-red}}{\rho_{NIR} + \rho_{V-red}}$$

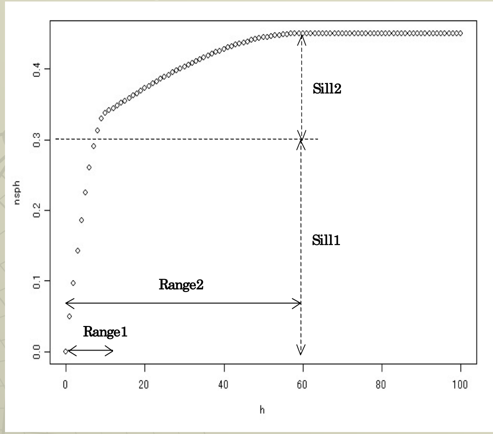
ρ_{NIR}, ρ_{V-red} radiance values of satellite sensors

Variogram characteristics reflect features of spatial structure of objects

- Definition of semi-variance & variogram characteristics: sill, range

$$\gamma_o(h) = \frac{1}{2N(h)} \sum_{k=1,N} (NDVI_k - NDVI_{k+h})^2$$

- Observed semi-variances fitted to 'nested spherical model' with two sets of variogram attributes(sill and range)



$$\gamma(h) = \begin{cases} \sum_{i=1,2} Sill_i \{ \frac{3}{2} \frac{h}{Range_i} - \frac{1}{2} (\frac{h}{Range_i})^3 \}, & for \ \ 0 < h < Range_i \\ \sum_{i=1,2} Sill_i, & for \ \ h > Range_i \end{cases}$$

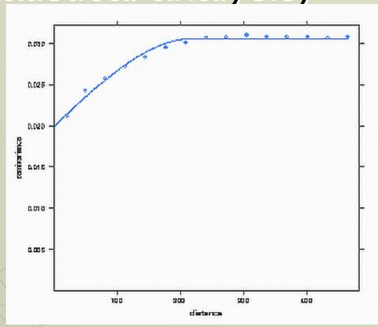
Variogram calculated by package 'gstat' in 'R' (by Pebesma,2004 for geostatistical analysis)

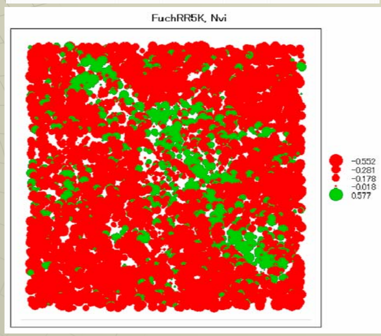
- A sample of spatial data set : 'frr.dat', 5000 observed points, 4 variables
-

```
> rr.fit <-
fit.variogram(rr.vgm,model=vgm(1,
"Sph",130,1))
> rr.fit
  model      psill   range
1   Nug 0.01990784   0.000
2   Sph 0.01063540 219.205
```

- > bubble(rr,"Nvi",main="FuchRR5K, Nvi ")
- Cf. NDVI map of 'Vegetation2' (2003/4/9)

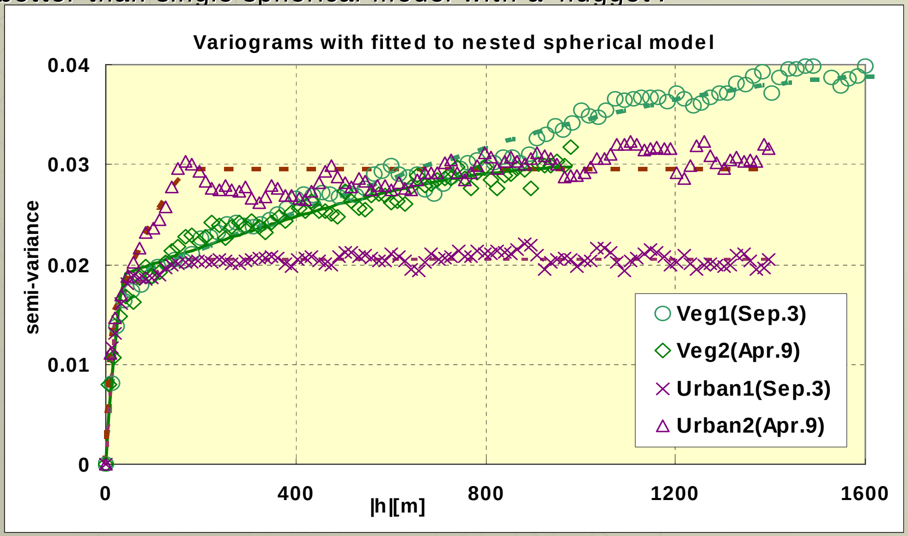
ID	X	Y	Nvi
1	646	5	-0.3967
2	156	6	-0.3599
3	465	6	-0.3053
4	628	6	-0.3004
5	105	6	0.2012
6	75	7	-0.3598





Variogram characteristics derived from ‘nls’ in ‘R’ (Nonlinear Least Squares Regression)

- Variograms for vegetation and urban areas with lines fitted to ‘nested spherical’ model.
- Nested spherical model fits observed variograms without any ‘nugget’ better than single spherical model with a ‘nugget’.



Conclusions

- Richly vegetated areas show large ‘Range’ of variogram, while urban areas show much smaller ‘Range’ value.
- Mixed of vegetated and non-vegetated area might reflect a rather large fluctuation in variogram as seen in ‘Urban2’.
- Relationship between percentile of vegetation coverage and a 'range' of variogram. Circles are derived from satellite observed data.