

Land-use/Land-cover Change Detection and Ecosystem impacts

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(1) Data user (CYCLOPES)

(2) Data provider (RISKMODEL)

Land-cover change

- Human-induced land-cover change
 - Land-cover conversion
 - Clear-cut logging, agricultural expansion, ...
 - Land-cover modification
 - Fuelwood collection, agricultural intensification, ...
- Natural land-cover change
 - Seasonal differences
 - Change in start of season between two years
 - Long-term climate driven changes
 - Northern hemisphere greenup, CO₂ enhanced vegetation productivity, desertification...

Science Questions

- Overall magnitude of changes
 - When, where, how much
- Separation of natural from human-induced change
 - Differences in magnitude, frequency, location
- Ecosystem impacts of change
 - Ecological significance
 - Resilience of systems
 - Feedbacks
- Underlying causes of change
 - Socio-economic determinants
 - Natural processes
 - Land-use policies



**The CYCLOPES project:
Development of high level medium
resolution sensors biophysical products
for regional to global applications.**



Université catholique de Louvain



Max-Planck-Institut für Meteorologie
Max Planck Institute for Meteorology

Max-Planck-Institut
für Biogeochemie



BACKGROUND

Large number of medium resolution satellites... but underexploited because most users require:

- High level products - but space agencies stop at low level products
- Long series of observations: continuity and consistency of global products
- Accurate products: fusion between sensors for improved products
- Validated products associated with confidence intervals

Objectives of CYCLOPES

Carbon Cycle and Change in Land Observational Products
from an Ensemble of Satellites

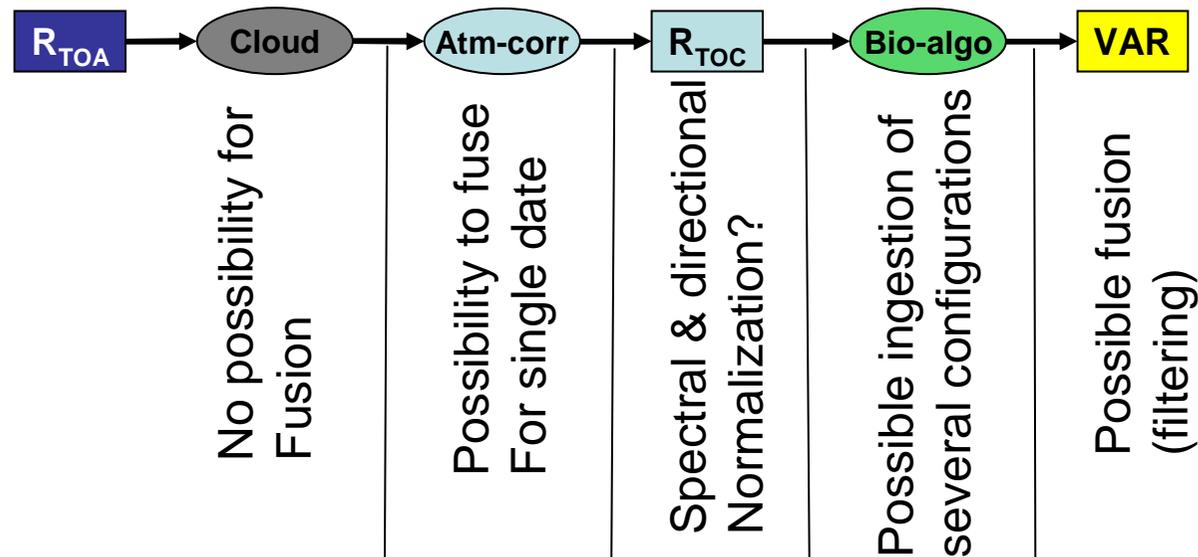
- Demonstrate the capacity of producing operationally consistent global fields of biophysical variables over long and continuous time series
- Use the products within two applications related to climate change issues (GMES):
 - Detection and categorization of land cover change (UCL)
 - Introduction within Global carbon cycle models

The Products

- Biophysical variables:
 - *Albedo*
 - *fAPAR*
 - *fCover*
 - *LAI*
- Resolution: 1km - 8km
- Temporal sampling: 10 days
- Coverage: Global
- Duration: 1997-2003
- Sensors:
 - *AVHRR*
 - *VEGETATION*
 - *POLDER*
 - *MERIS*
 - *(MSG)*

Principles

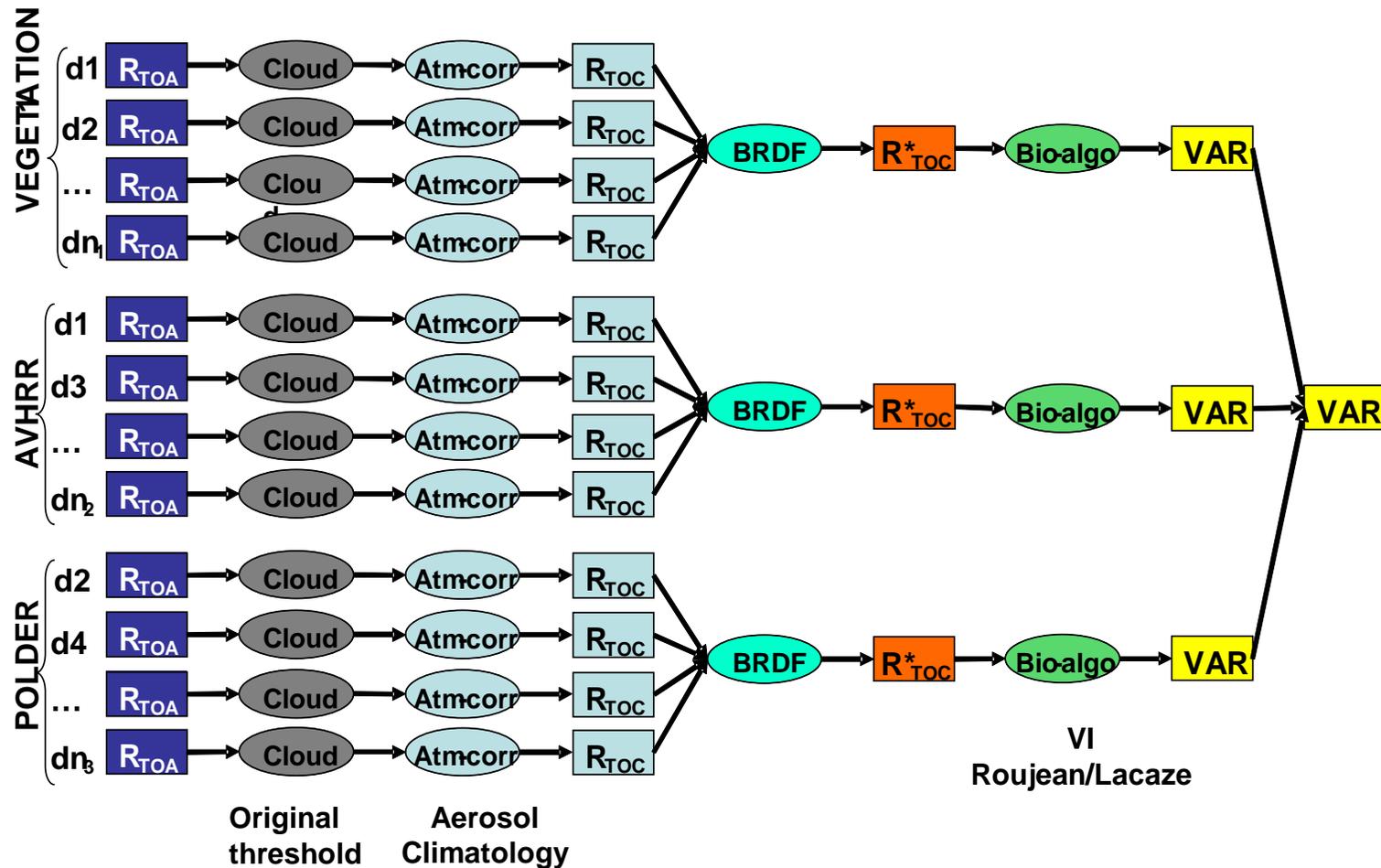
- Temporal compositing
- Fusion between sensors



- Incremental production
 - First version deriving from available algorithmic modules
 - Up-dates every 6 months: inclusion of improvements in each modules and in multi-sensor fusion
- Validation and accuracy assessment

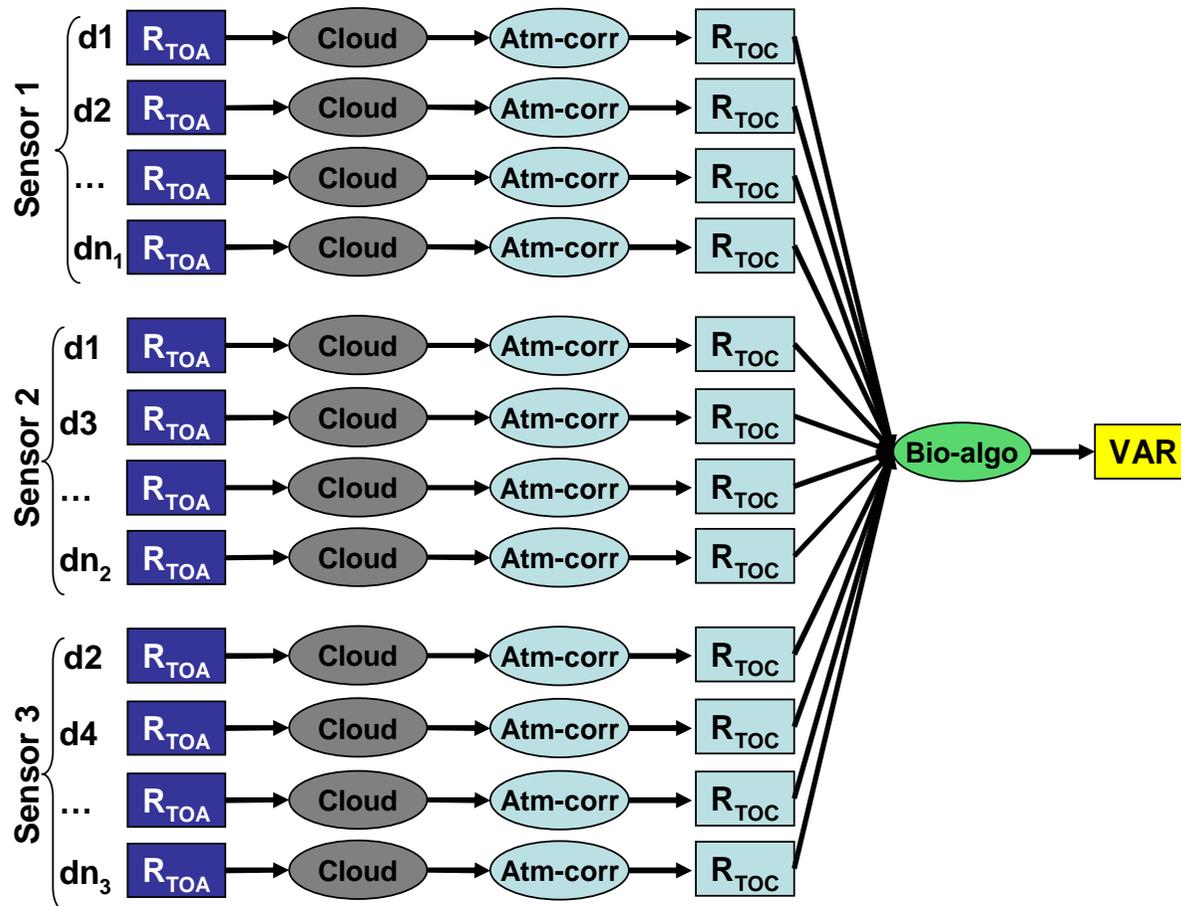
Version 1 (April 2004)

- global 8km for 2002-2003
- Africa-Europe for 1km 2002-2003 (VGT)

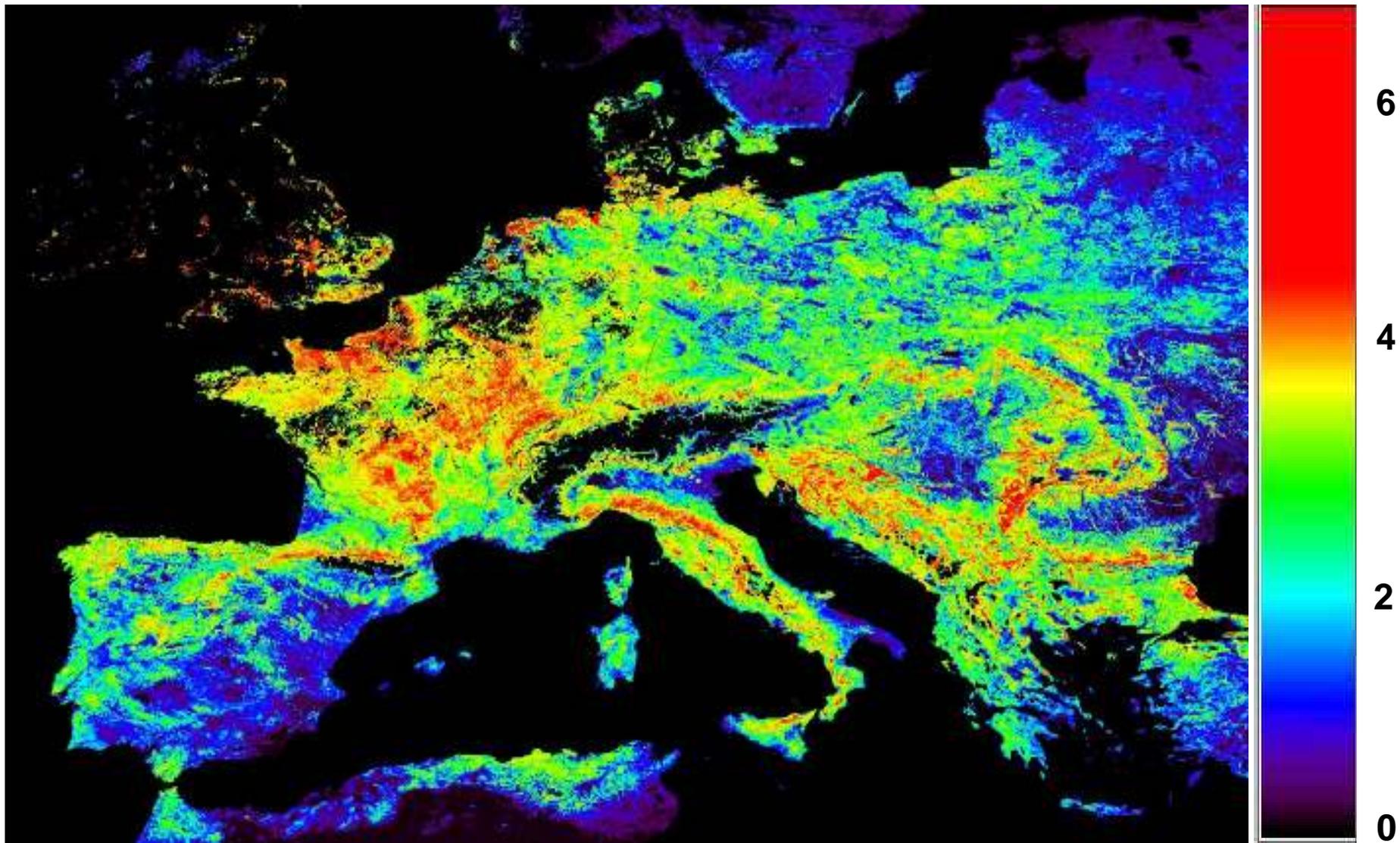


Version 4 (August 2005)

Improved multi-sensor fusion



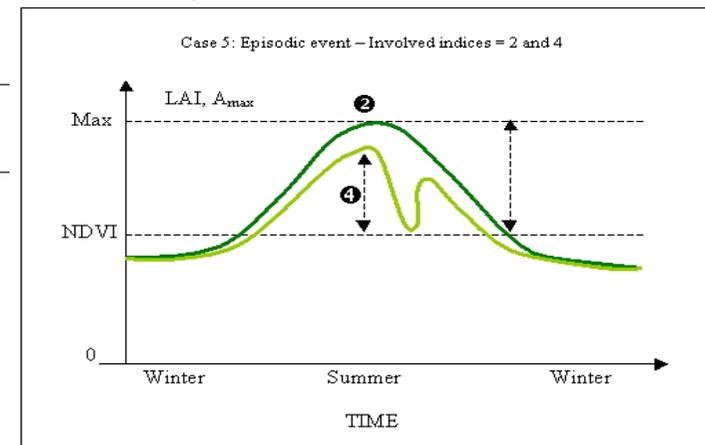
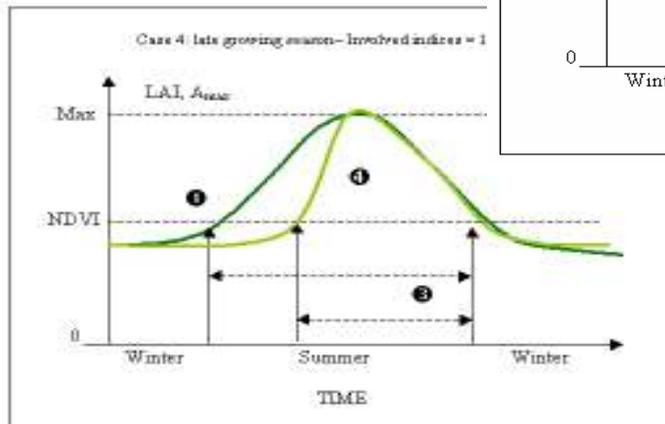
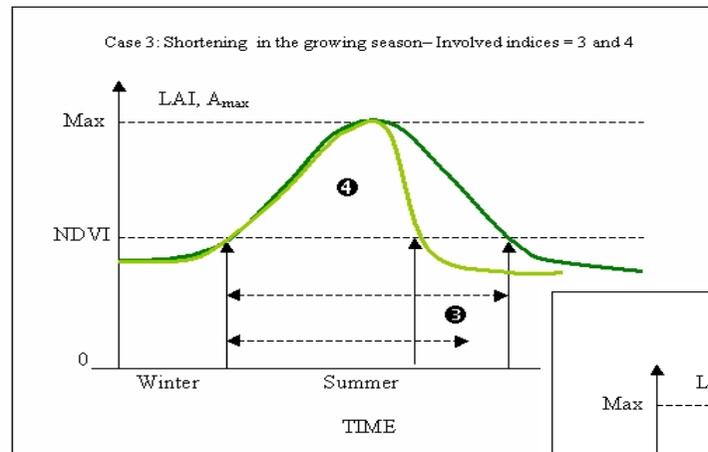
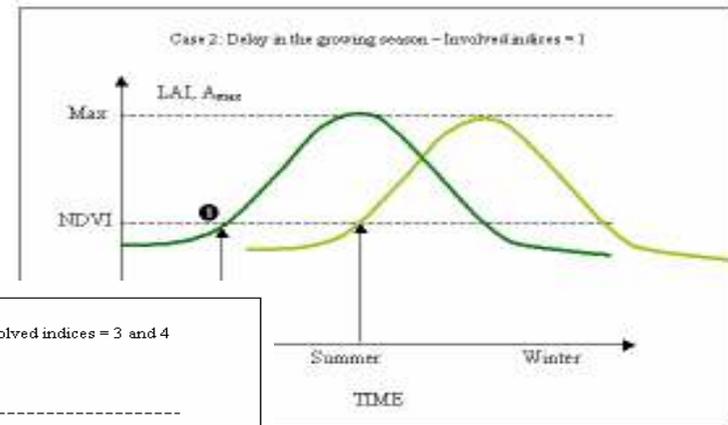
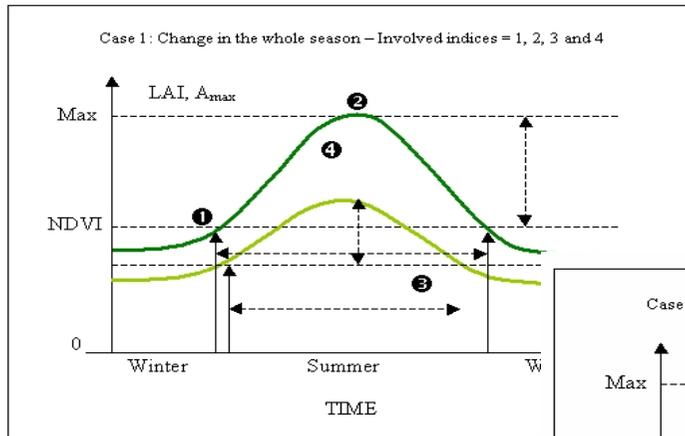
PRODUCT example for Version 1: Europe 14/05/2003



Land-cover change analysis:

- Identifying and Quantifying Change:
 - Inter-annual analyses
 - Detailed inter-annual comparisons
 - Indicators of change
 - Measuring phenology
- Characterizing and Interpreting Change:
 - Characterize specific contributions to change
 - Relate cause to change
 - From end-user perspective
 - Validation

Inter-annual Change



Change Indicators

- Change Vector
 - Difference of annual profile vectors

$$CV = I_2 - I_1$$

- Change Vector Indices

- Change Vector Magnitude

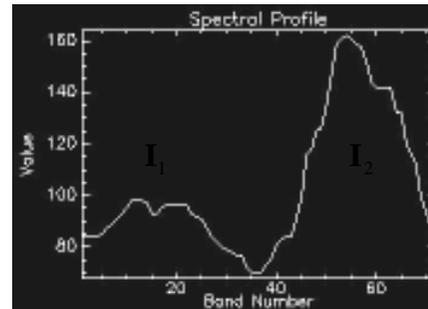
- $$CVM = \sqrt{\sum_{i=1}^n (I_2 - I_1)_i^2}$$

- Sum (cumulative change)

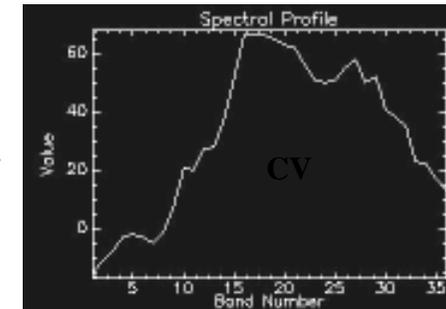
- $$SUM = \sum_{i=1}^n I_2 - I_1$$

- Phenological Indices

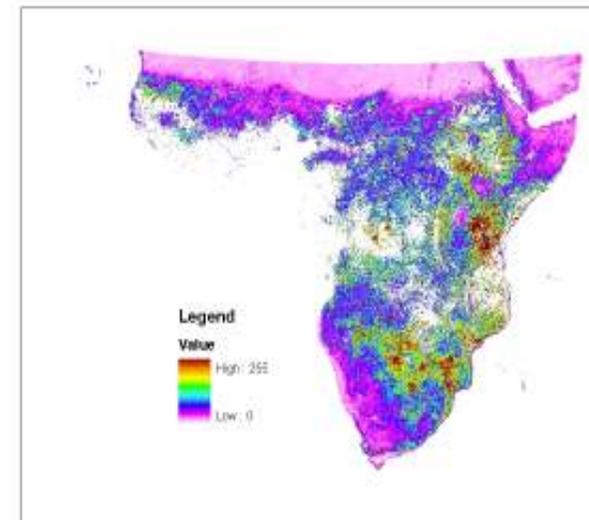
- *Start of Season*
- *Cumulative Index*



NDVI Profiles

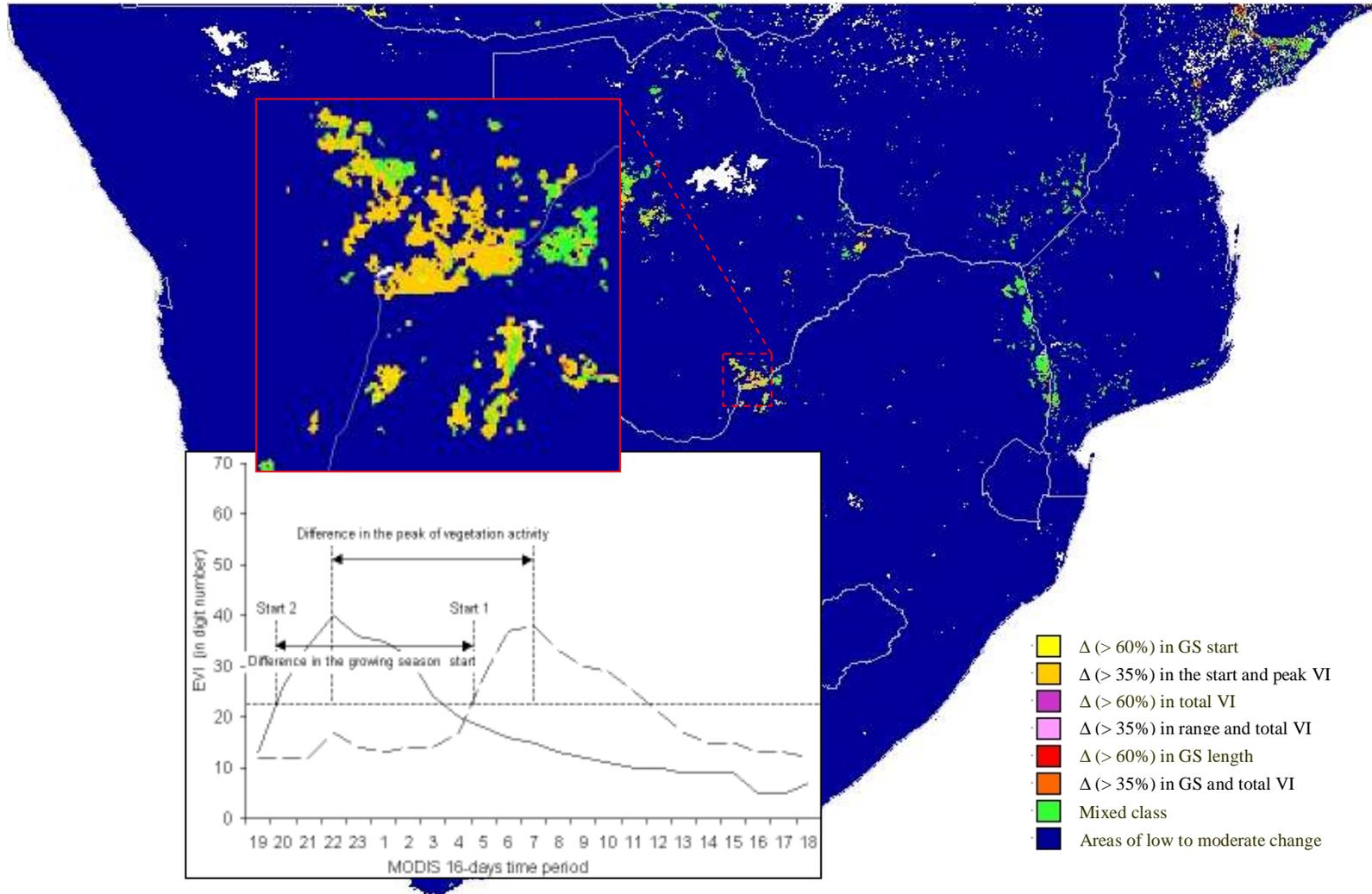


Change Vector



Change vector magnitude – Sept 2000 – Sept 2002

Categorizing Change (GLOVEG project)



Examples of clustering the processes in areas of high land cover change based on phenological indices

Sensitivity to data quality

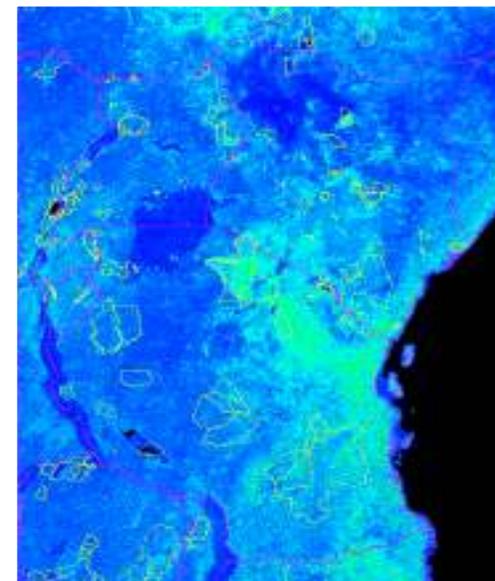
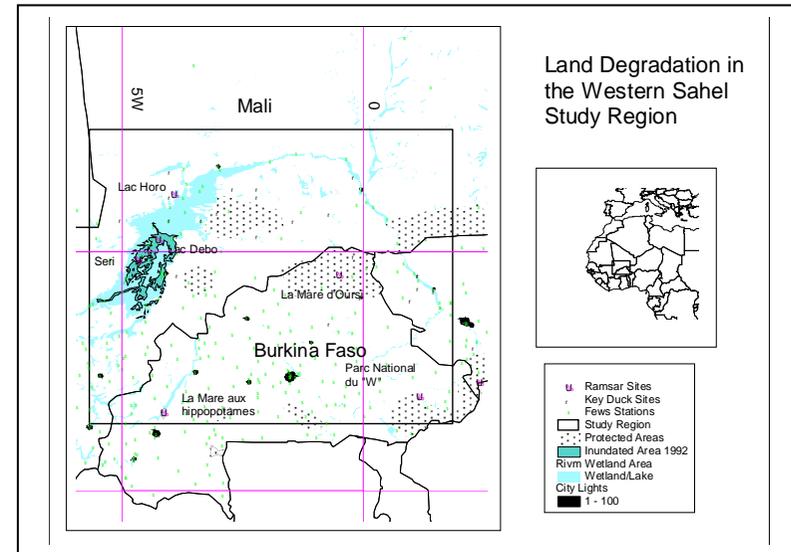
- Successive versions of CYCLOPES data *versus* SPOT VEGETATION S10 & D10 *versus* MODIS data
- Thresholds in data quality to meet specific user needs
- For different users and user requirements

End-Users and Applications

- **Changes at the seasonal scale:**
 - Disaster monitoring and ecosystem recovery assessment (fire, floods)
 - Changes in habitat favorable to pest outbreak (locusts, ...)
 - Seasonal differences and the influence on carbon cycle
- **Interannual changes and land degradation**
 - Impacts of grazing, fuel collection, recurring fire use
 - Agriculture intensification
- **Decadal scale land-cover change**
 - Changes in vegetation cover, desertification
 - Influence on regional and global climate

Interpreting Change

- Meeting information needs of targeted users
 - International conventions
 - National governments
 - NGOs
- Relate change analyses to particular problems
- 2 case studies:
 - International environmental convention resolution in Mali
 - Conservation requirements in Kenya

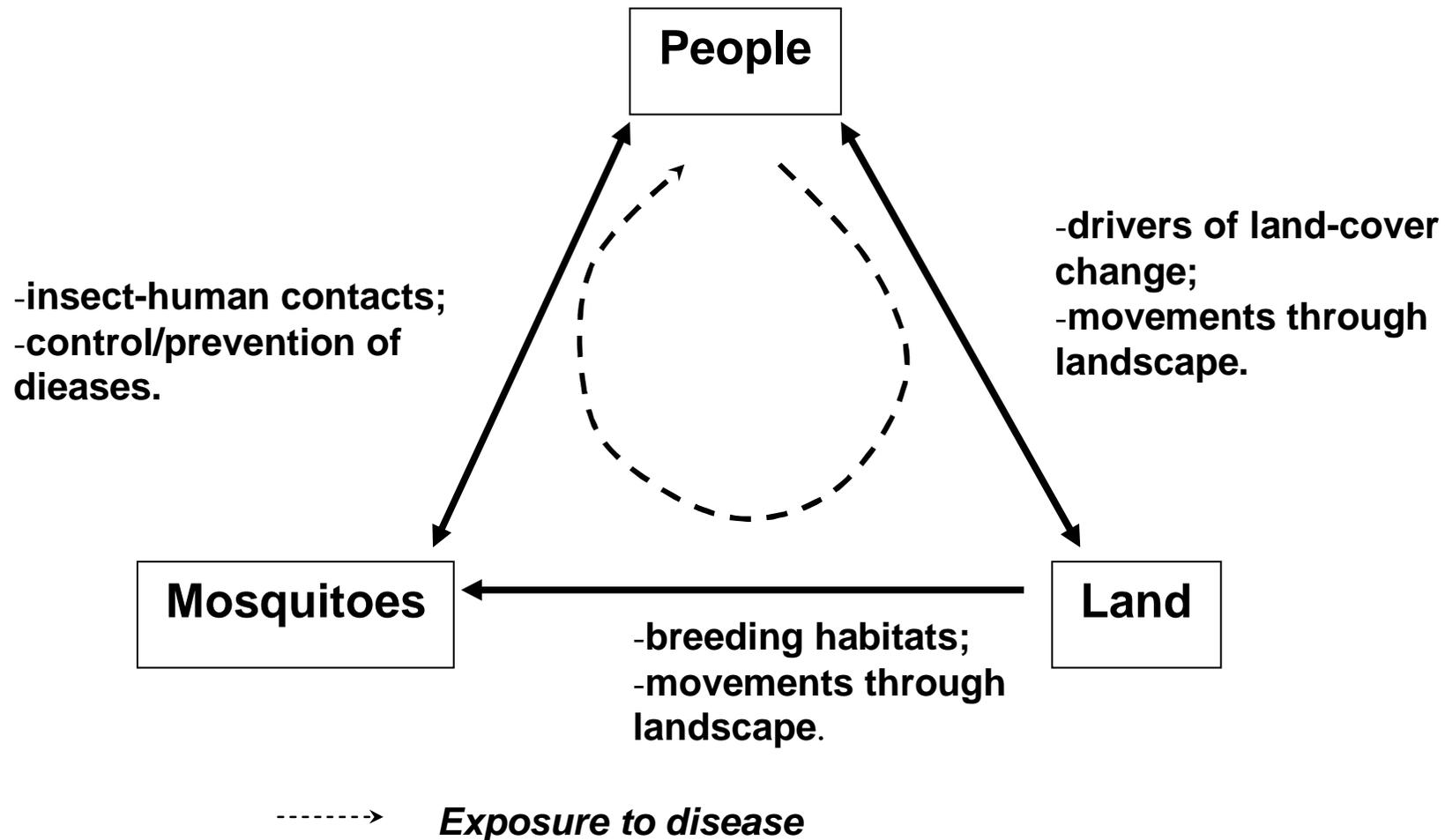


Low CVM
High CVM

Protected areas

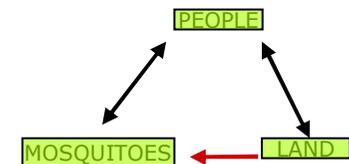
National boundaries

RISKMODEL: Predicting the RISks of Mosquito borne DisEases from Land Use change



RISKMODEL: land-mosquitoes link

- Land use and larval habitat availability
- Larval habitat characteristics and mosquito abundance/species composition
- For example:
 - Occurrence of vegetated stream margins in orchards?
 - Abundance of *Anopheles minimus* in stream margins?



RISKMODEL: spatial components

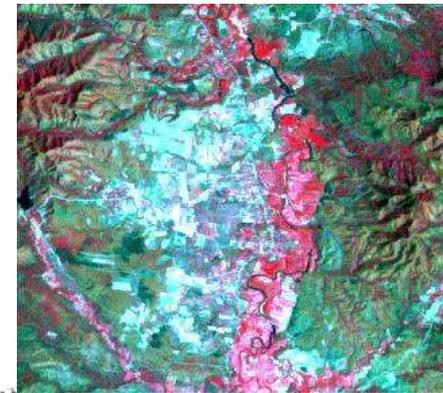
- Spatial components of the project:
 - mosquito collection are georeferenced
 - people belong to households that are located within villages
 - changes in land use and land cover are mapped



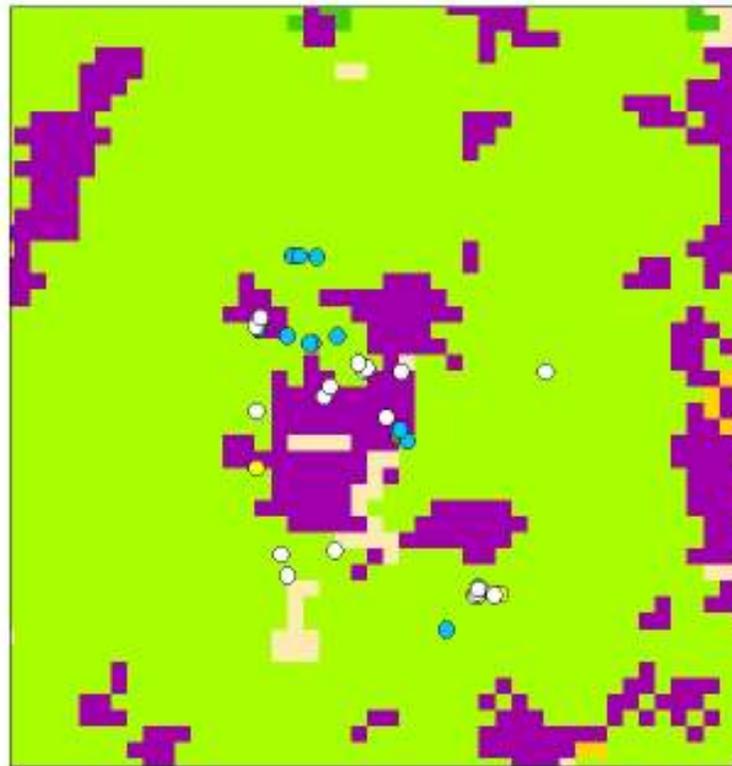
Nong Khao Klang



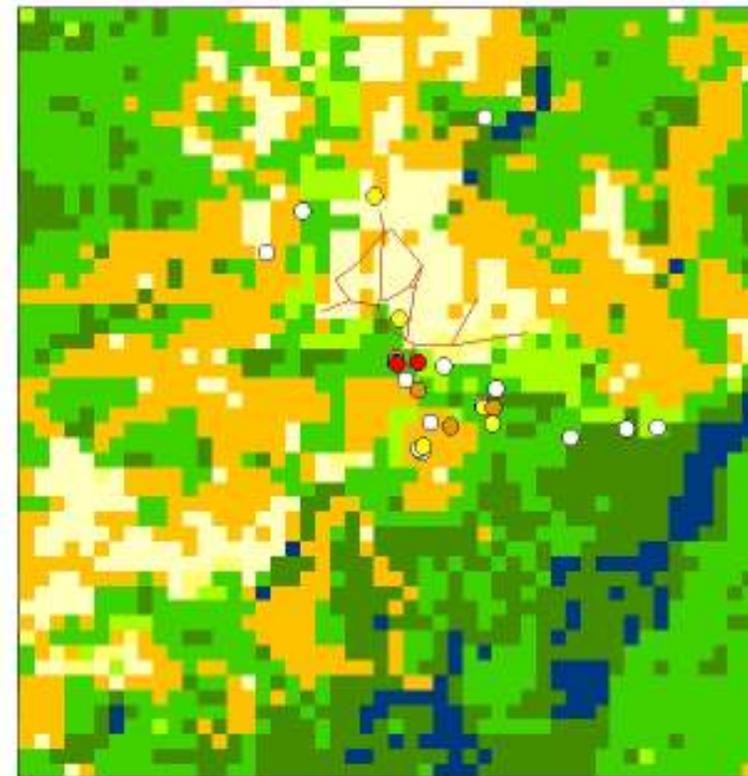
SFy
0 - 0.25
0.25 - 0.5
0.5 - 0.75
0.75 - 1
Housumbere nong khao klang.zip
Streets of nong khao klang.zip



Examples of mosquito-land cover analysis



Site 4: Ban Pa Nai
Anopheles larvae collection



Site 3: Ban Huai Chang Kham
Anopheles larvae collection



Land cover & vector ecology

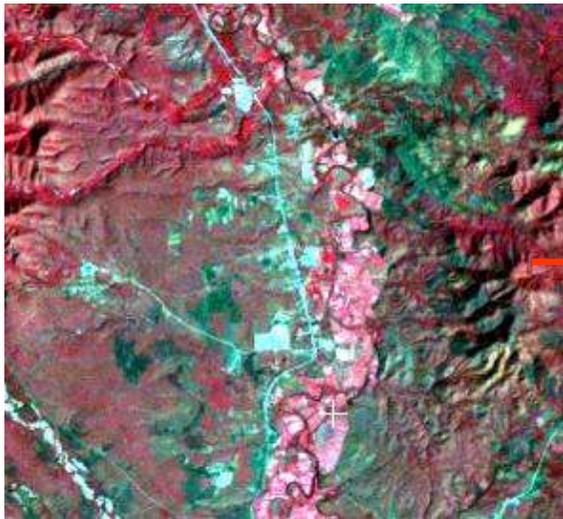
	Mixed deciduous	Dry/ fallow forest	Bare soils	Irrigated (wet)	Orchards/ house garden	Total
Absence of larvae	5	6	3	17	9	40
An. minimus	1	0	0	1	0	2
An. barbirostris	3	2	0	2	0	7
An. minimus + An. barbirostris	2	4	0	0	0	6
An. hyrcanus	0	0	0	11	3	14
An. barbirostris + An. hyrcanus	0	0	0	1	1	2
	11	12	3	32	13	71

→ different species in different landscape units

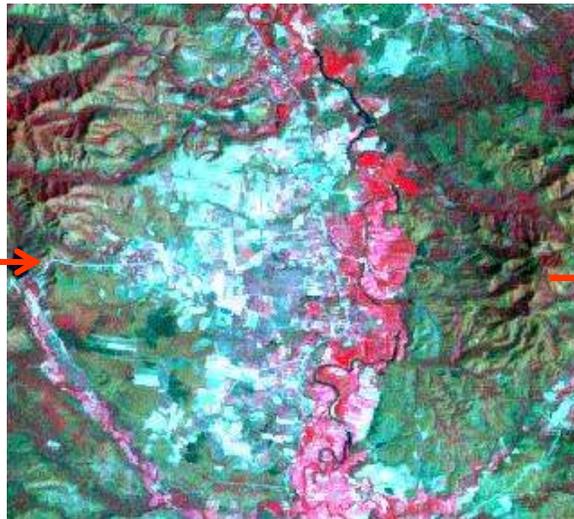
→ micro-habitat characteristics related to land cover categories

Land cover change mapped based on Landsat images: 1989 and 2000

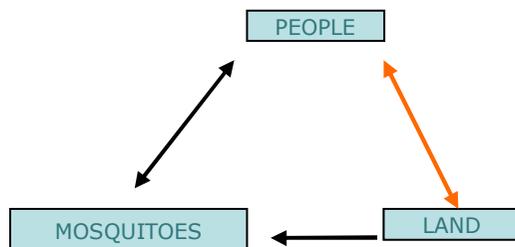
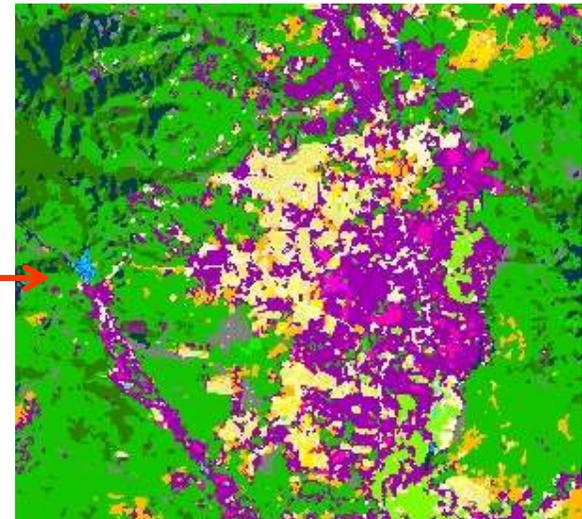
1989



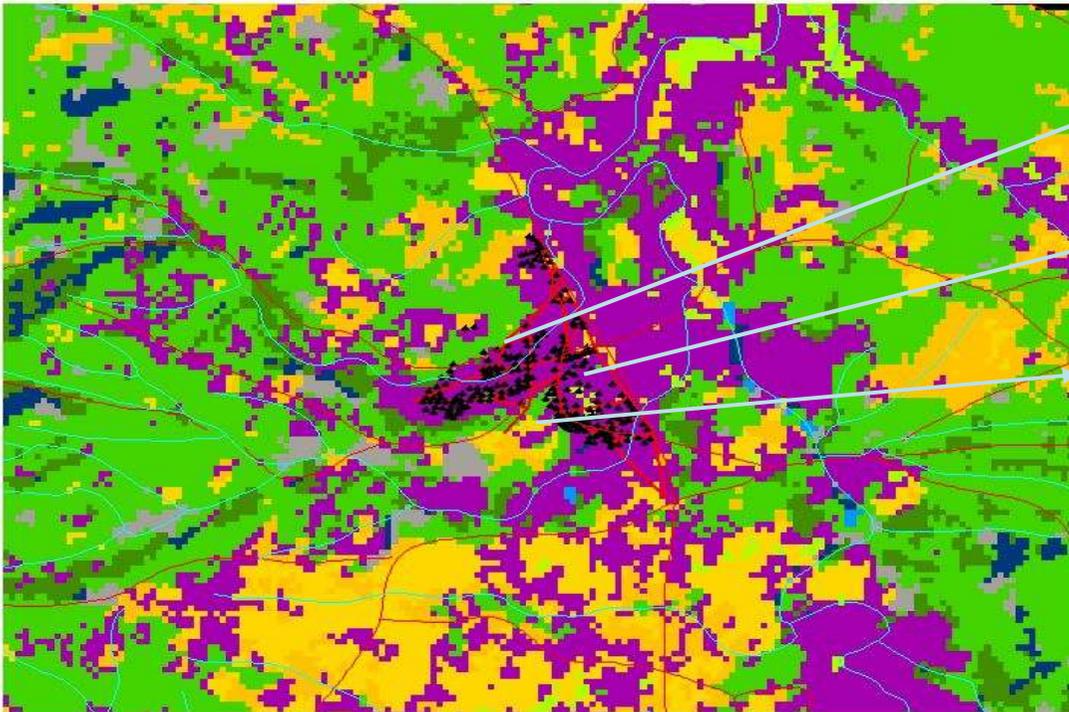
2000



change

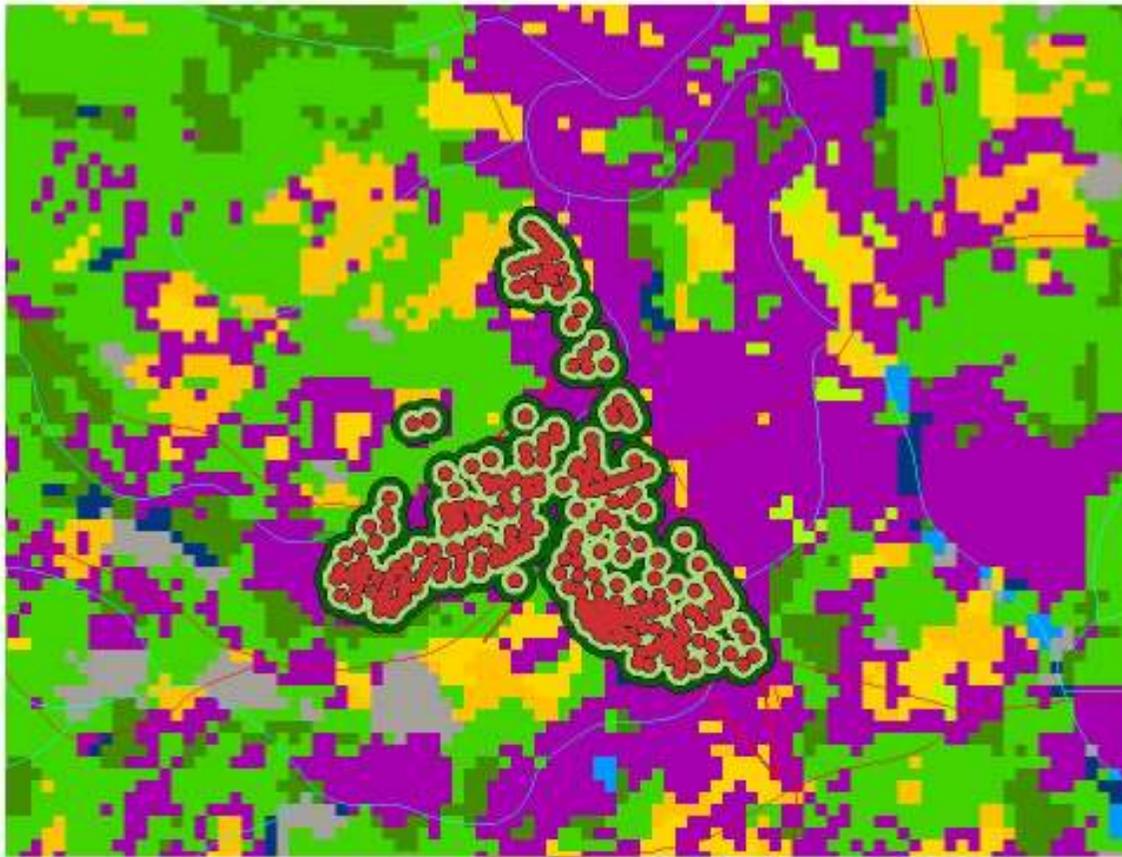


Land cover and epidemiology (1)



REGSTRHH	LATITUDE	LONGITUDE	INFECTION	CASES
214/1	18,11843	98,89032
203	18,11836	98,89043		
224	18,11828	98,89053		
225	18,11808	98,89070		
223/1	18,11793	98,89085		
222	18,11783	98,89095		
216	18,11743	98,89111		
216/2	18,11707	98,89126		
209	18,11639	98,89154		
208	18,11557	98,89197		
211	18,11605	98,89137		
205	18,11529	98,89168		

Land cover and epidemiology (2)



Spatial analyses:
distance to..., land
cover within a
distance x (buffer
analysis), ...