BELGIAN SCIENCE POLICY

Mapping malaria vectors in South East Asia

Combining remote sensing and ecological niche model analysis

DYNMAP

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Background:

Remote Sensing derived product potentially useful for malaria control

BUT ➡ Up-to-date detailed useful information is rarely available

- Coarse/medium resolution offer cheap frequent timely info but not enough details
- High resolution images available but on small areas and at high cost
- Derived product such as land cover are more adapted to non specialist but often out of date due to the lengthy production process

Available choices = NOT relevant for the purpose

DYNMAP innovation project:

Dynamic predictive mapping using multi-sensor data fusion: Demonstration for malaria vector habitat

Objectives:

1. Develop a Bayesian Data Fusion method to provide up-to-date land descriptors
2. Perform predictive mapping of major malaria vector *Anopheles dirus*

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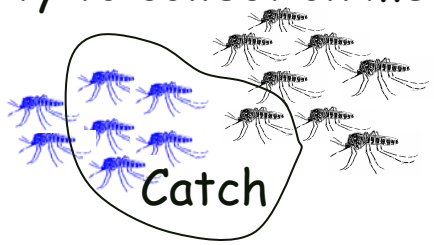
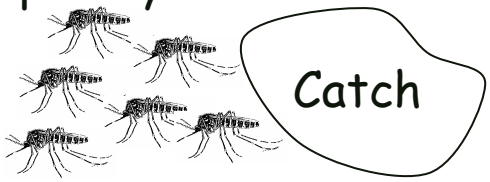
Predictive modelling adapted to species habitat

Abundance between species ~
sensitivity to collection method



Use Presence/Absence data only

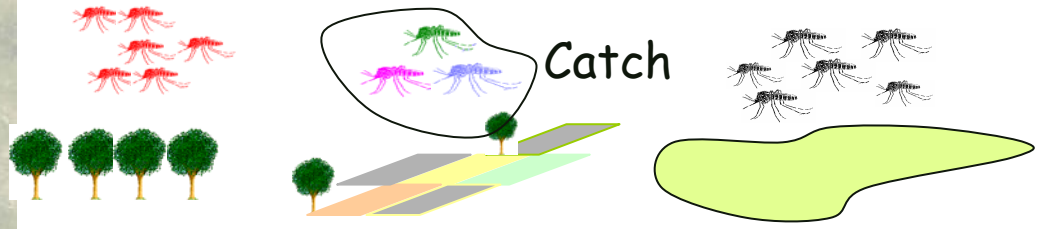
Absence ~ Difficult to catch,
Sampling strategy not adapted,
Temporary adverse condition



Use Presence data only or give more weight to presence data

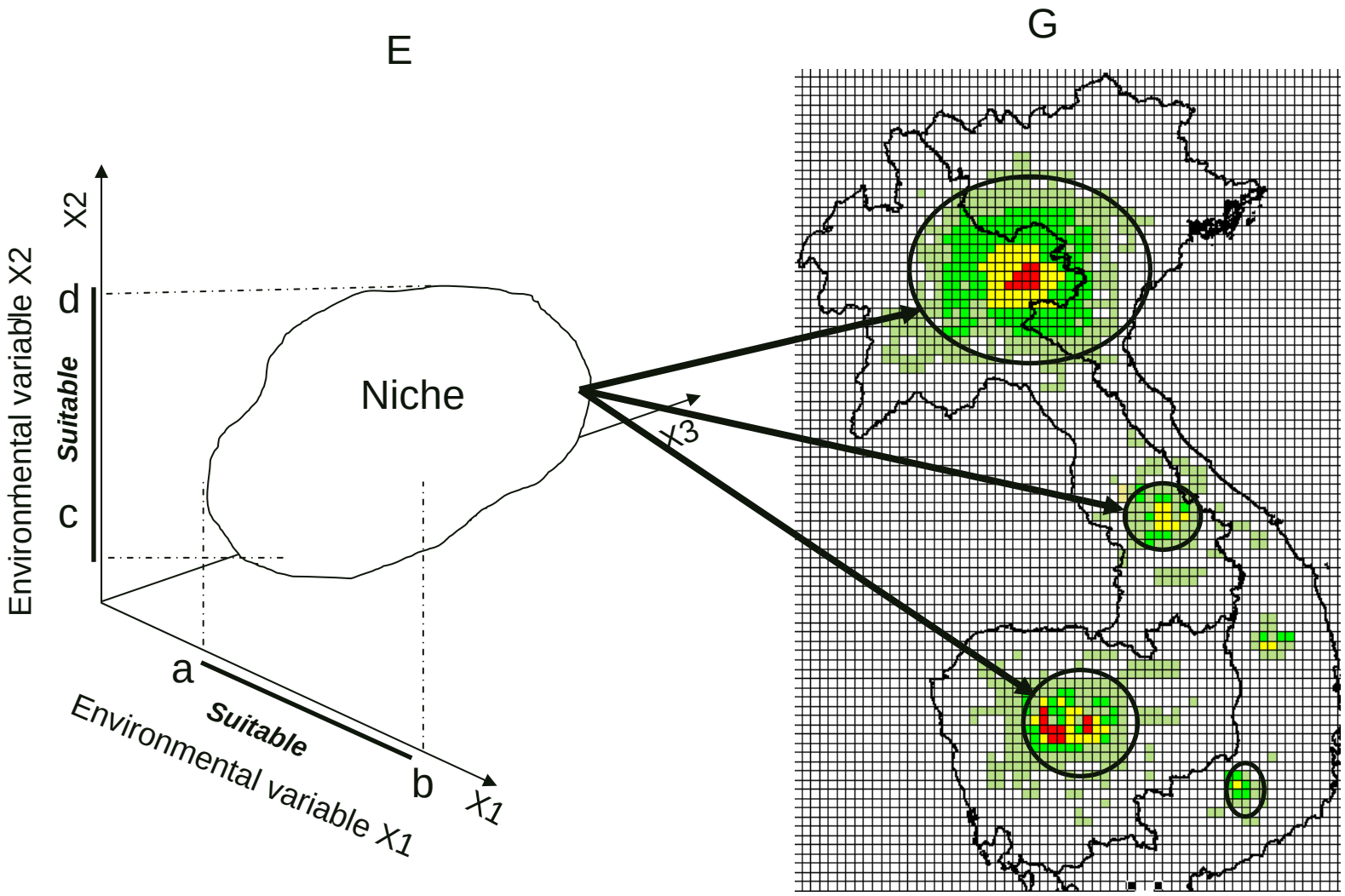
Ecological Niche Modelling offers powerful solutions

Absence for two species ~
Not necessarily association



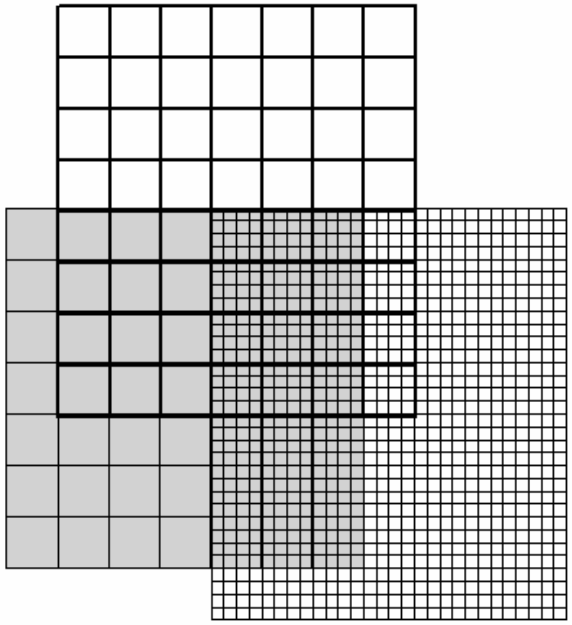
Do not use double absence

Ecological Niche Modelling concepts



Soberon (2007) hierarchical framework

Abiotic Slow changing
Large region
Coarse resolution
Museum records



Biotic Fast changing
Small region
Fine resolution
Field records

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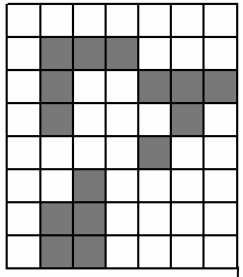
2. Data and methodology

1km

Potential



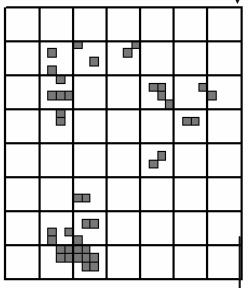
Abiotic factors **Long term data**

Rainfall (abundance/pattern)
Temperature
Topography and soil type
Relative humidity
Worldclim, CRU cl2.1, USGS GTOPO30, FAO

200 museum records covering Asia

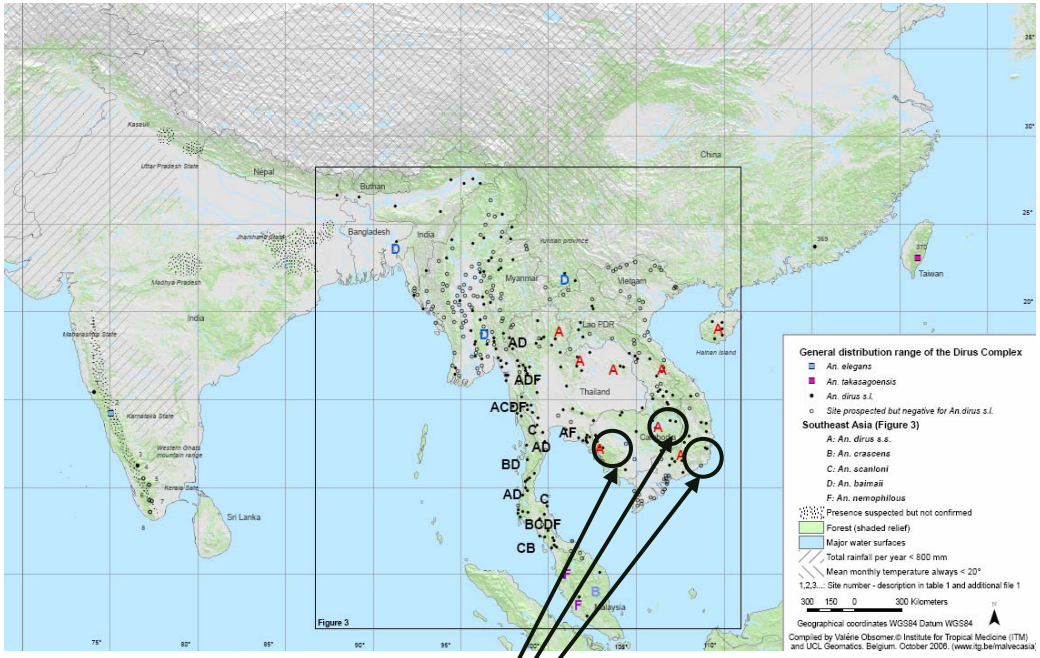
300m

Realised



Biotic factors **Up-to-date**

Forest cover for 2005
Globcover (ESA) modified



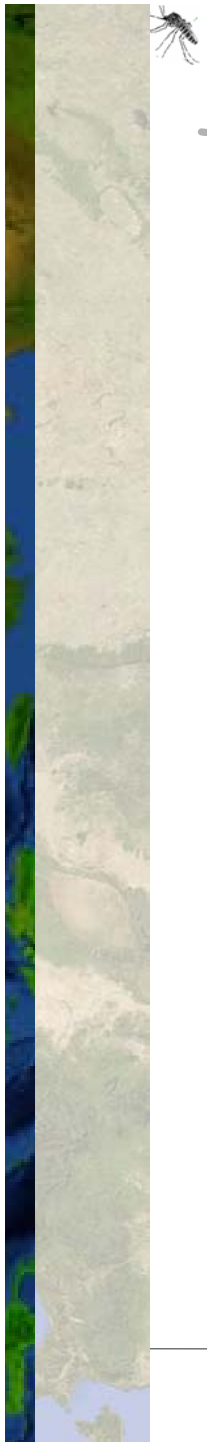
5m

Local study

Biotic factors **Up-to-date data**

Detailed satellite images spot (HRV) for 2005

50 sites in Cambodia and Vietnam
Covering 2004 to 2006 in 3 sites



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4. An. dirus s.l. potential distribution: long term abiotic factors.

MAXENT

Define the suitable niche using information derived from environmental factors values in the cells occupied by individual

Ecological modelling technique based on the maximum entropy principle

Using presence only data

Good performance for transferability in area with sparse data

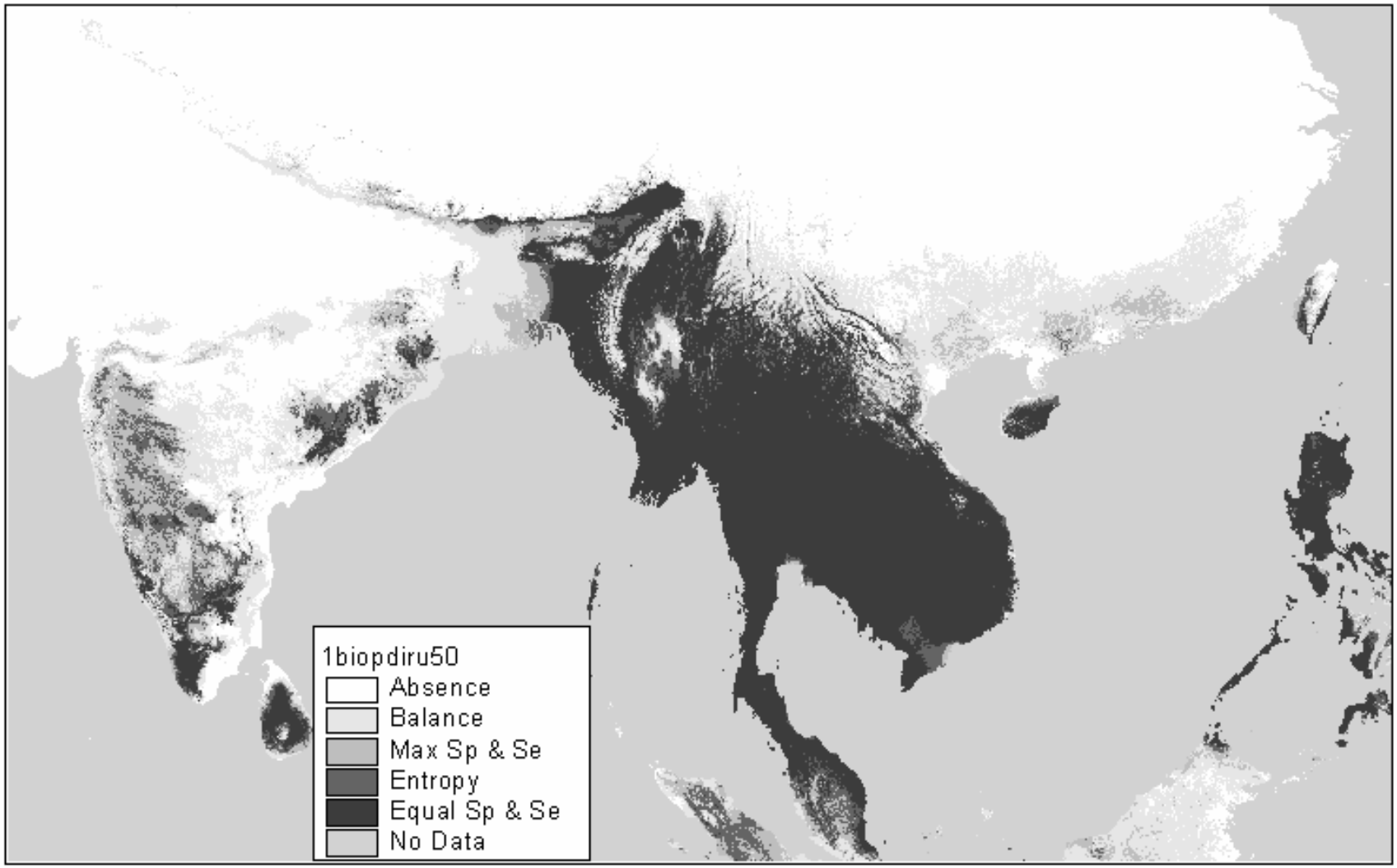
Good model performance

Run using 50% set aside as test sample

Definition of a threshold value to transform probabilities into presence/absence

⟹ Maximise the sum of specificity and sensitivity

4. An. dirus s.l. potential distribution: long term abiotic factors.



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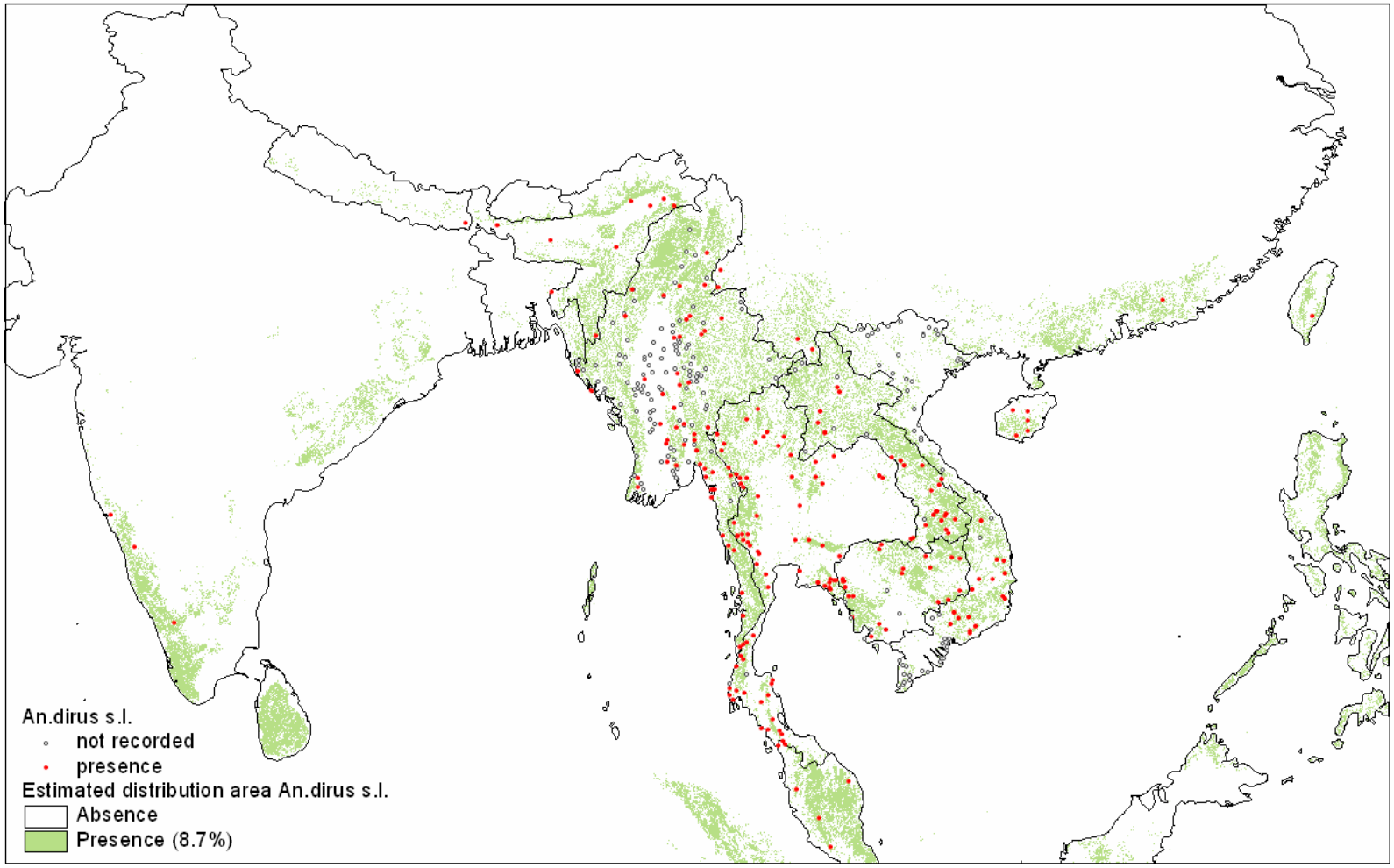
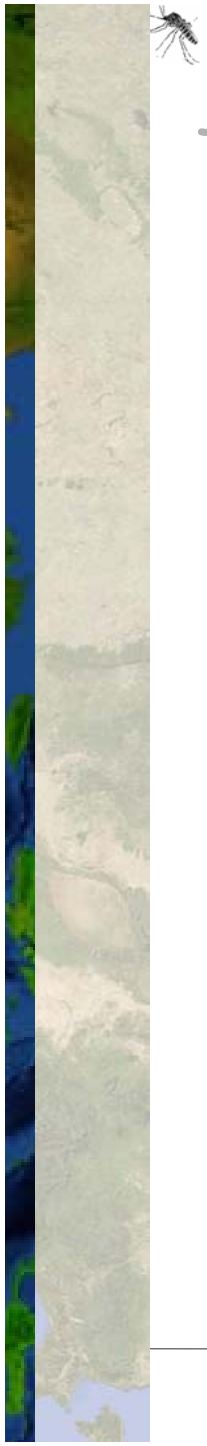
4. Approaching the realised niche: medium scale biotic factors



Publication

Obsomer V., Steven P., Defourny P., Coosemans M. Distribution area for the species of the Anopheles dirus complex: ecological niche and environmental influences. Submitted to PLoS One.



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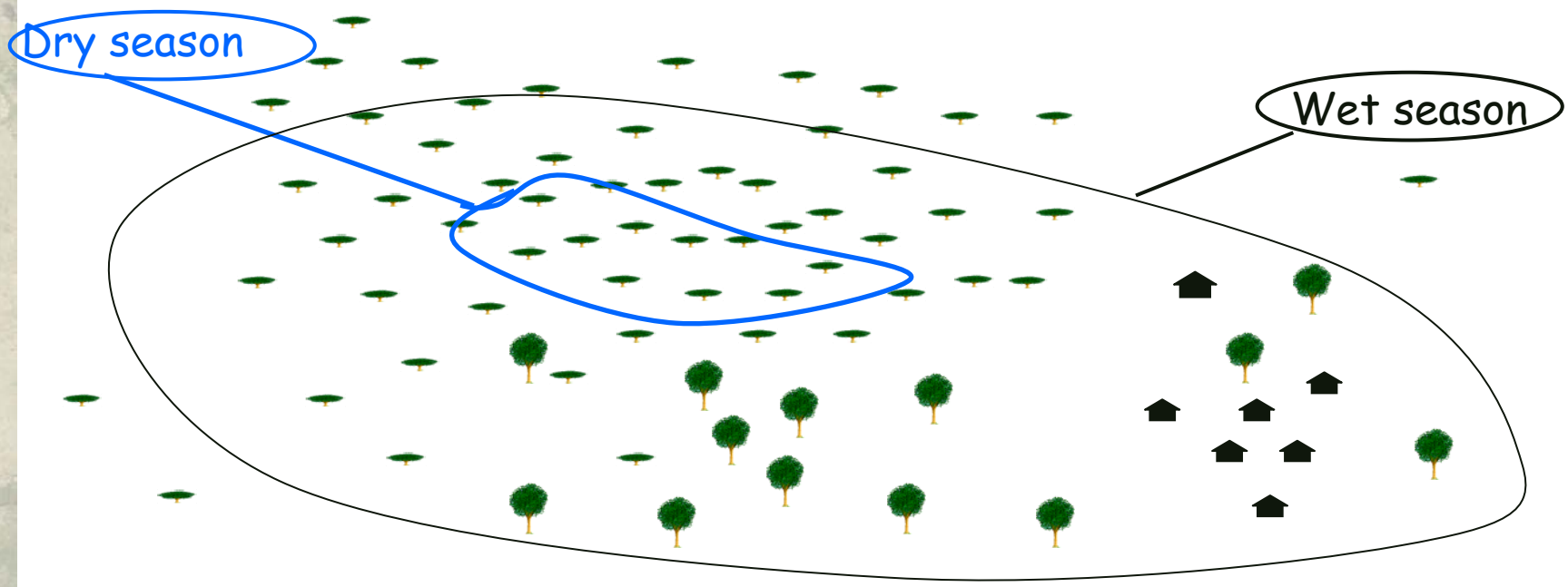
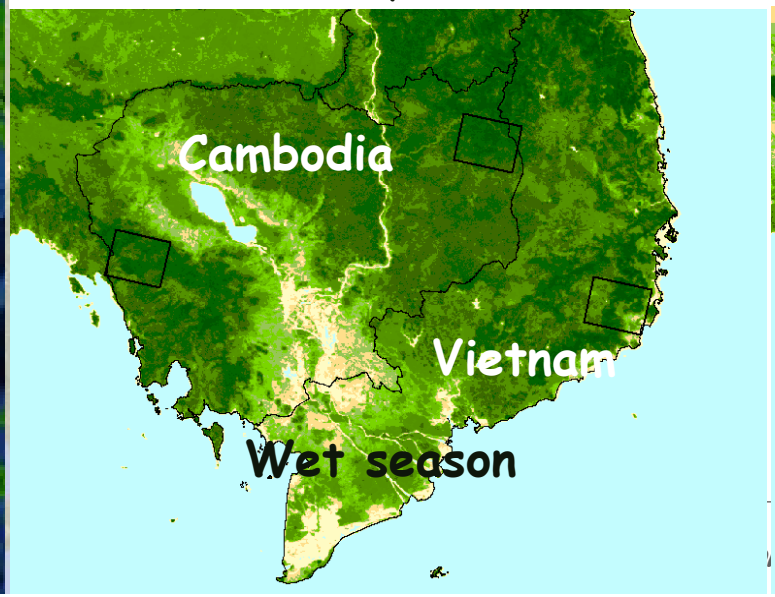
Delineation of restricted zone for dry season vector habitat



3 forested study areas with contrasted seasons

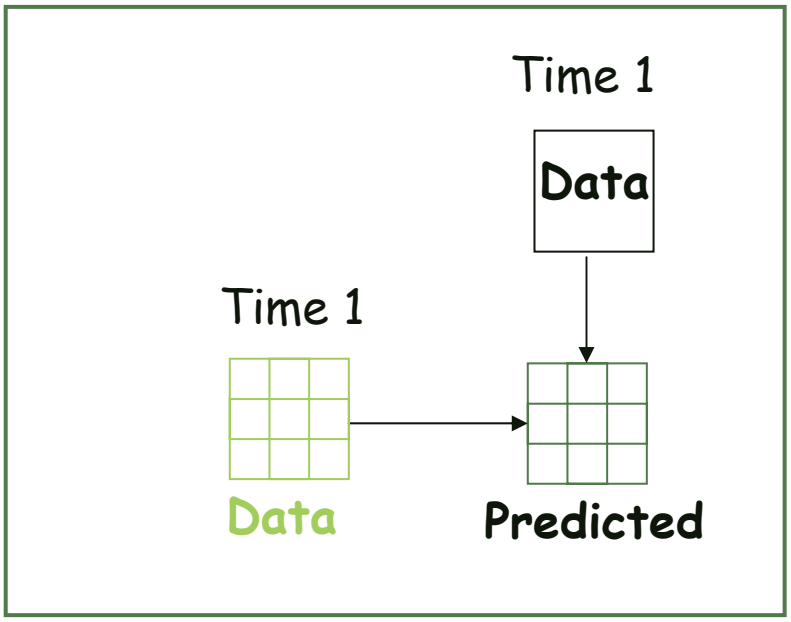


Need for up-to-date land descriptors

Bayesian data Fusion method

Bayesian data Fusion: Fusion of images from different resolution

Good performance



Tests

Multispectral /panchromatic images:	Spot 5 HRG Landsat ETM
Multi-sensor fusion:	Spot HRG and vegetation

Publication

Fasbender, D., Radoux, J., Bogaert, P. (2008). Bayesian data fusion for adaptable image pansharpening. IEEE Transaction on Geoscience and Remote Sensing. 46 (6) 1847-1857

Fusion Multi-spectral and panchromatic images (spot)

$$\mathbf{Y} = g(\mathbf{Z}) + \mathbf{E}$$

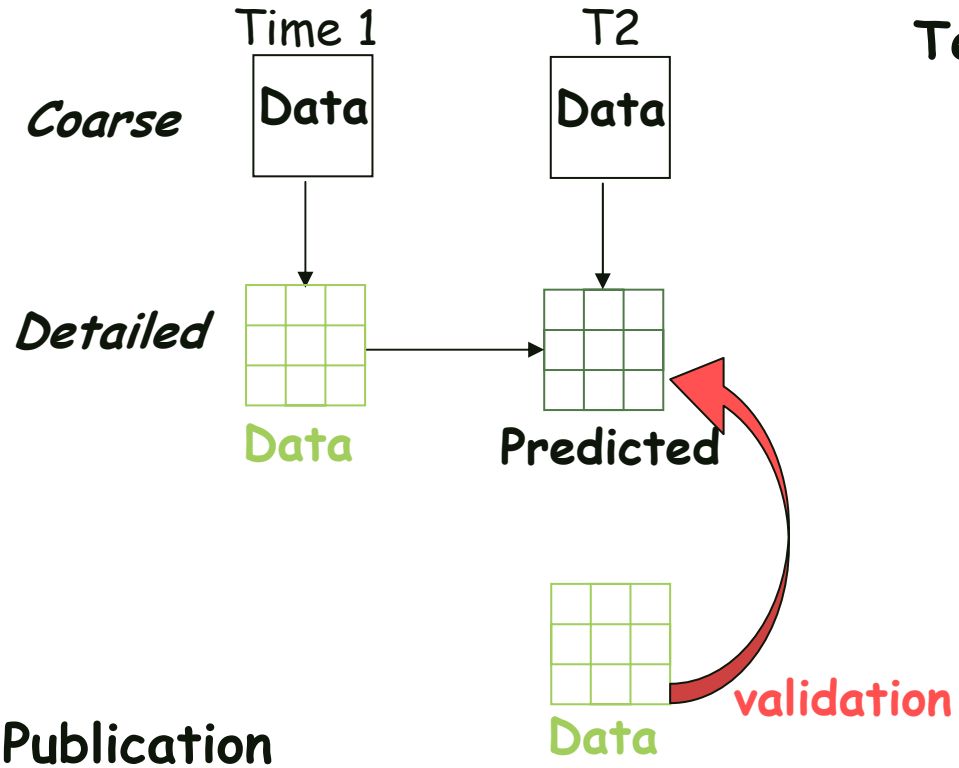
$$f(\mathbf{z}|\mathbf{y}) \propto f_{\mathbf{Z}}(\mathbf{z}) f_{\mathbf{E}}(\mathbf{y} - g(\mathbf{z}))$$

$$f(\mathbf{z}|\mathbf{y}) \propto f_{\mathbf{Z}}(\mathbf{z}) \prod_{i=1}^{n} f_{E_i}(\mathbf{y} - g(\mathbf{z}))$$

B_1	B_2	B_3	B_4	Pan−Intensity
0.97	0.97	0.98	0.97	0.80

Bayesian data Fusion: temporal fusion

Good performance for visual interpretation but to much noise for land cover classification



Test

Spot 5 HRG - VEGETATION

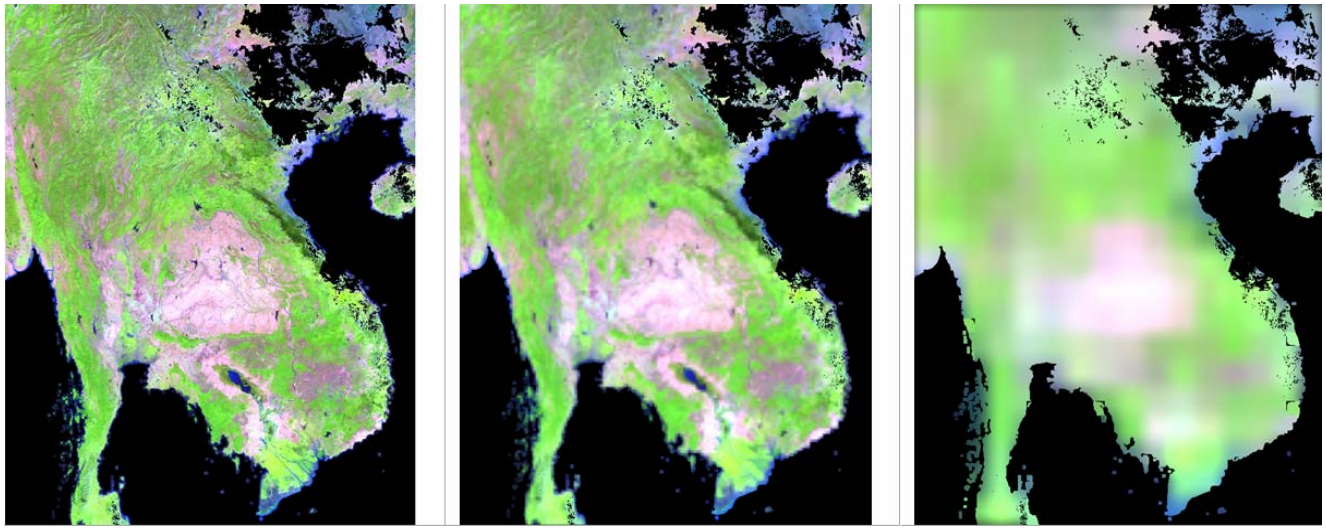
LANDSAT - VEGETATION

VEGETATION 1-10- 100 km

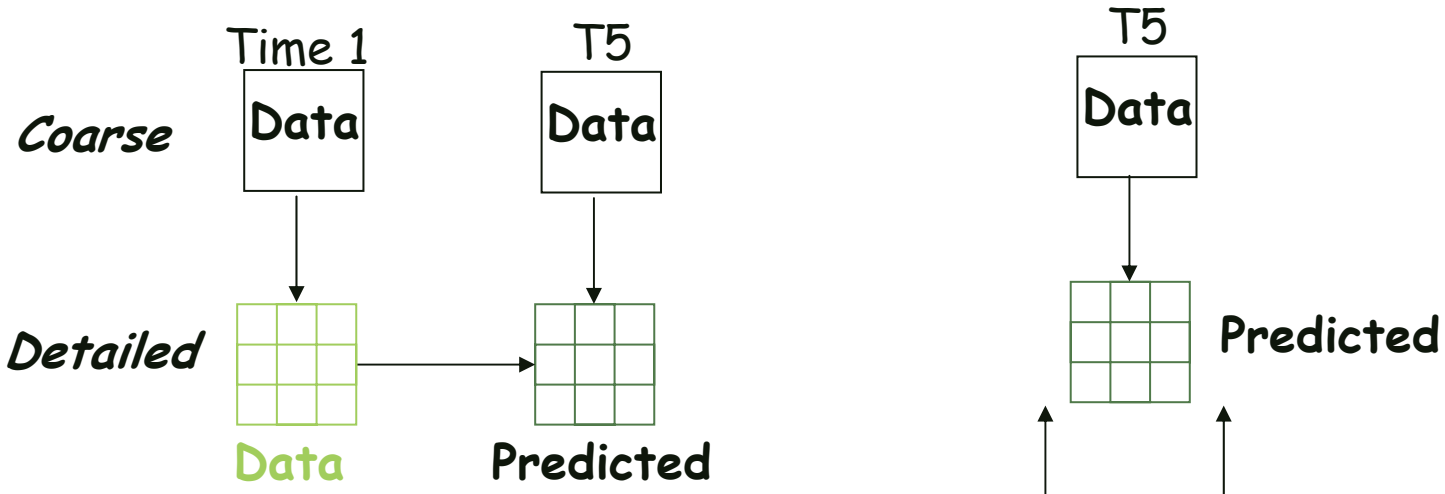
Publication

Dominique Fasbender, Valérie Obsomer, Patrick Bogaert and Pierre Defourny. (2009) Updating Scarce High Resolution Images with Time Series of Coarser Images: a Bayesian Data Fusion. Sensor and Data Fusion,editor Nada Milisavljević, ISBN978-3-902613-52-3, pp.490, I-Tech, Vienna, Austria.

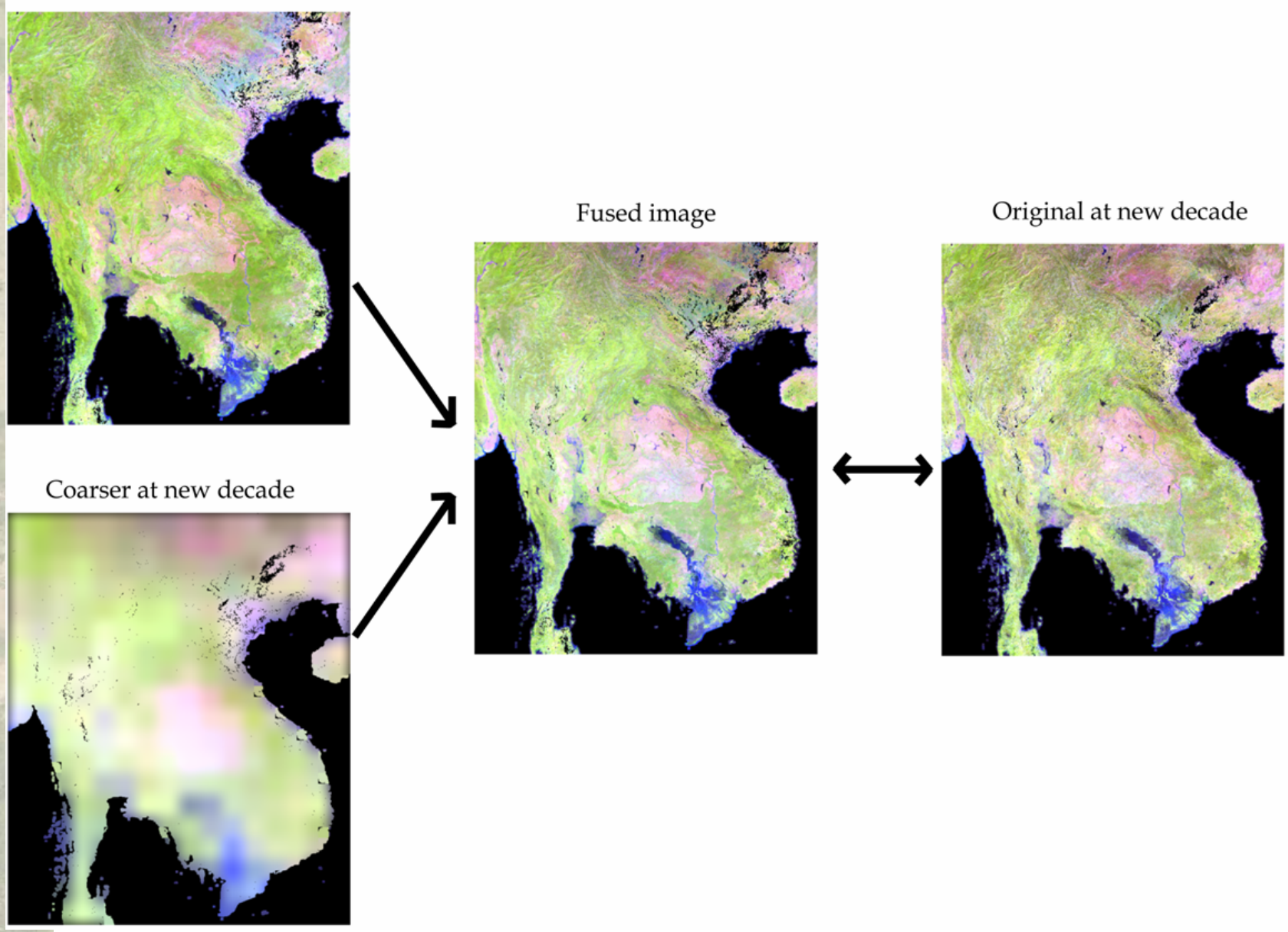
Fusion VEGETATION 1km, 10km - 100km



2005



2004


Original at previous year
Coarser at new decade
Fused image
Original at new decade

Conclusion

- Hierarchical framework concept of ecological niche mapping offer opportunities for integration of multi-scale analysis
- The project achieved successful predictive mapping of potential distribution for *An. dirus s.l.* at a scale of 300m resolution
- The new Bayesian data Fusion (BDF) method show good performance for pan-sharpening of same sensor or multi-sensor images
- Multi-temporal fusion experiments carried on during this innovation project showed promising results but not sufficient to derive up-to-date land descriptors

Perspectives

- New multi-temporal fusion experiments are currently carried on in the context of normalisation of high resolution image using low resolution for uniformisation prior to mosaic building
- Local study sites are currently investigated using land descriptor derived from available detailed images