Landsat Science Team: Issues and Priorities

- Curtis Woodcock (Boston University)
- Tom Loveland (USGS EDC)

EDC Jan 08

Landsat Science Team

- Rich Allen (U Idaho) - thermal - water resources
- Martha Anderson (USGS ARS) - thermal - water resources
- Alan Belward (European Commission) - deforestation data policy and access
- Bob Bindschadler (NASA GSFC) cryosphere
- Warren Cohen (USFS PNW) - forests, carbon and change
- Feng Gao (ERT - GSFC) data fusion - international sensors
- Sam Goward (UMD) kitchen sink (LTAP, future sensors, forests, change …)
- Dennis Helder (SDSU) - calibration
- Eileen Helmer (USFS) - tropical forests - change
- Rama Nemani (NASA Ames) - LAI
- Lazaros Oreopoulos (UMBC) - Clouds
- John Schott (RIT) - Water Quality and Sensors
- Prasad Thenkabail (USGS) - Irrigated Agriculture
- Eric Vermote (UMD) - Atmosphere/Clouds
- James Vogleman (SAIC EDC) - Ecosystem Change
- Curtis Woodcock (BU) - operational land cover change
- Mike Wulder (CFS) - forests, carbon, land cover change
- Randy Wynne (VPI) - forest applications
- A number of Co-Is!!!!!

Ongoing Issues

- Getting access to all Landsat imagery
- Coordination with ESA on Sentinel 2
- Push for a new future mission (L9)
- Long term solution to observation strategy

Landsat Data Products (current plans)

- Surface Reflectance and Temperature
  - Recommendations for standard products
  - Clear path forward
  - Need an implementation plan
- Cloud and Shadow Masking
  - Bakeoff coming (lots of approaches, no good understanding of which work best when and where and why)
  - need for ground truth images, particularly for clouds (David Roy helping!!

What Next? Land Cover Products???

What should a high resolution land cover product look like?

- Accurate representation of land cover at any time (maps)
- The differences between times (maps) are representative of change in land cover

Don't forget about the importance of the time dimension!!

Future Issues (my take)

- Operational land cover change monitoring
  - Definition and implementation of a standard product
- Cloud screening the archive
  - Routinely cited as the primary impediment to more automated use of Landsat imagery over large areas/multiple time periods
- Reconstructing the history of the surface of Earth in the satellite era
  - A community agenda
- Definition of longer term sensing scenarios
  - What should happen after L9?

Accuracy Assessment of Global Land Cover Products

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Dept of Geography, Friedrich Schiller University
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Overview

1. As the land cover community matures, an increasing emphasis on validation and accuracy assessment
    i. Difficult
    ii. somewhat unpleasant
    iii. surprisingly expensive
    iv. Essential (Whither ECVs?)

2. In Coordination with CEOS Working Group on Cal/Val GOFC-GOLD LC IT is trying to support the broader community through validation

3. Idea is to collect ground reference data independent of any single land cover product to support validation of many land cover datasets

4. Intent is to supplement and complement ongoing validation activities associated with individual land cover datasets

GOFC-GOLD

Notion of a "Best Currently Available" Land Cover Map

Combine the strengths of multiple sources of land cover data across multiple extents and resolutions (national, regional and global sources)

Based on what is learned in the validation exercise

A transparent and community endorsed activity

LCCS compatibility is critical

Simple guidance criteria:
    more accurate is better
    finer spatial resolution is better
    more thematic detail is better

"Best Practices Document"

Strahler et al., 2006

GLOBAL LAND COVER VALIDATION:

RECOMMENDATIONS FOR EVALUATION AND

ACCURACY ASSESSMENT OF

GLOBAL LAND COVER MAPS

GOFC-GOLD GLOBAL OBSERVATION OF FOREST AND LAND COVER DYNAMICS

EUROPEAN COMMISSION
DIRECTORATE-GENERAL
Joint Research Centre

2006

EUR 22156 EN
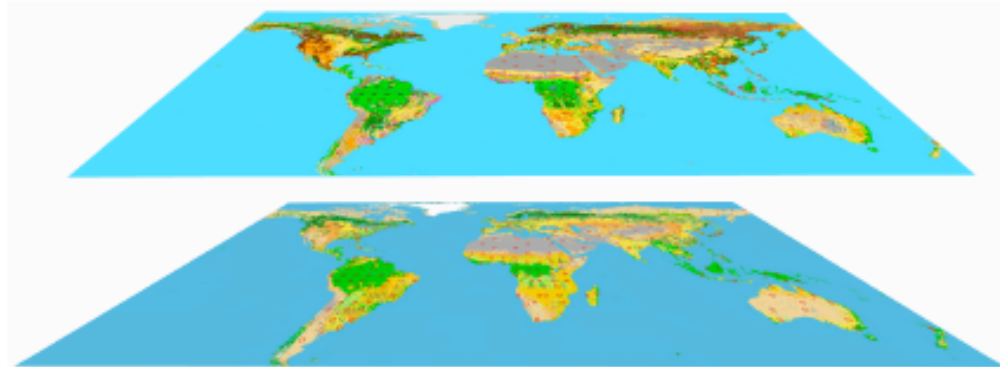
A "Living Reference Dataset"

A set of validation sites distributed around the globe

Based on very high resolution imagery (1m or less) interpreted by regional experts (the regional networks)

Checked annually for land cover change, and updated periodically

Limited set of land cover classifiers
        life form - (trees, shrubs, herbacious)
        leaf type
        leaf phenology

Sampling Design

- Random, stratified, global sampling

- Continents and national boundaries not taken into account

- Must be indepedent of land cover (LC) products – strata can not be based on any LC product

- Strata based on the Koppen Climate System, population density and land/water proportion

- 500 5 X 5 km blocks sampled globally

World map of Köppen-Geiger climate classification

Af	BWh	Csa	Cwa	Cfa	Dsa	Dwa	Dfa	ET
Am	BWk	Csb	Cwb	Cfb	Dsb	Dwb	Dfb	EF
Aw	BSh		Cwc	Cfc	Dsc	Dwc	Dfc	
	BSk				Dsd	Dwd	Dfd	

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Contact : Murray C. Peel (mpeel@unimelb.edu.au) for further information

Original Koppen classes

|	
■	Af. Tropical Rainforest
■	Am. Tropical Monsoon
■	Aw. Tropical Savannah
■	BWh. Arid Desert Hot
■	BWk. Arid Desert Cold
■	BSh. Arid Steppe Hot
■	BSk. Arid Steppe Cold
■	Csa. Temp Dry Summer Hot Summer
■	Csb. Temp Dry Summer Warm Summer
■	Cwa. Temp Dry Winter Hot Summer
■	Cwb. Temp Dry Winter Warm Summer
■	Cwc. Temp Dry Winter Cold Summer
■	Cfa. Temp No dry season Hot Summer
■	Cfb. Temp No dry season Warm Summer
■	Cfc. Temp No dry season Cold Summer
■	ET. Polar Tundra
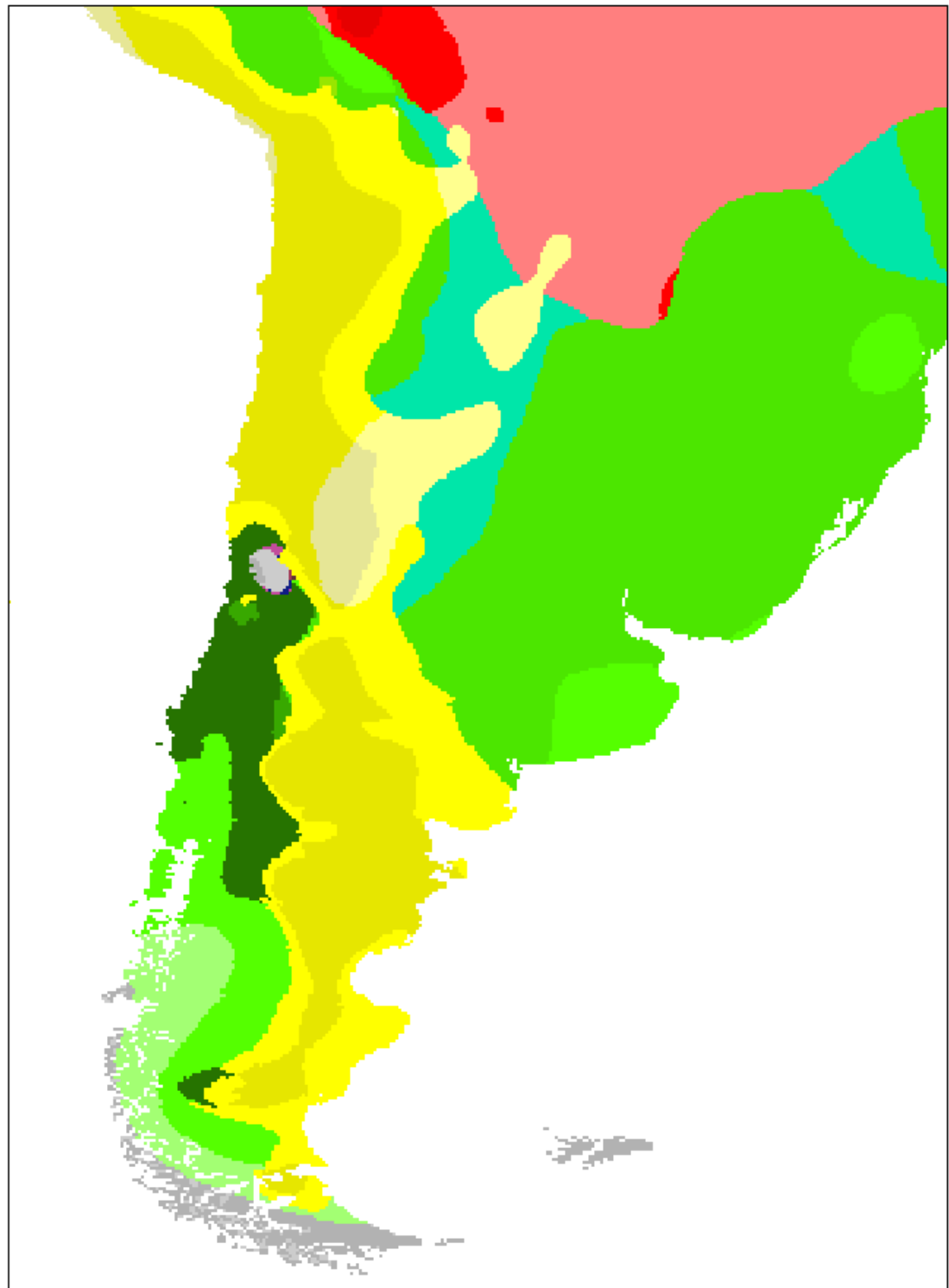
Edited Koppen classes

Legend:
- Tropical Rainforest
- Tropical Seasonal Forest
- Tropical Savannah
- Desert
- Steppe
- Mediterranean
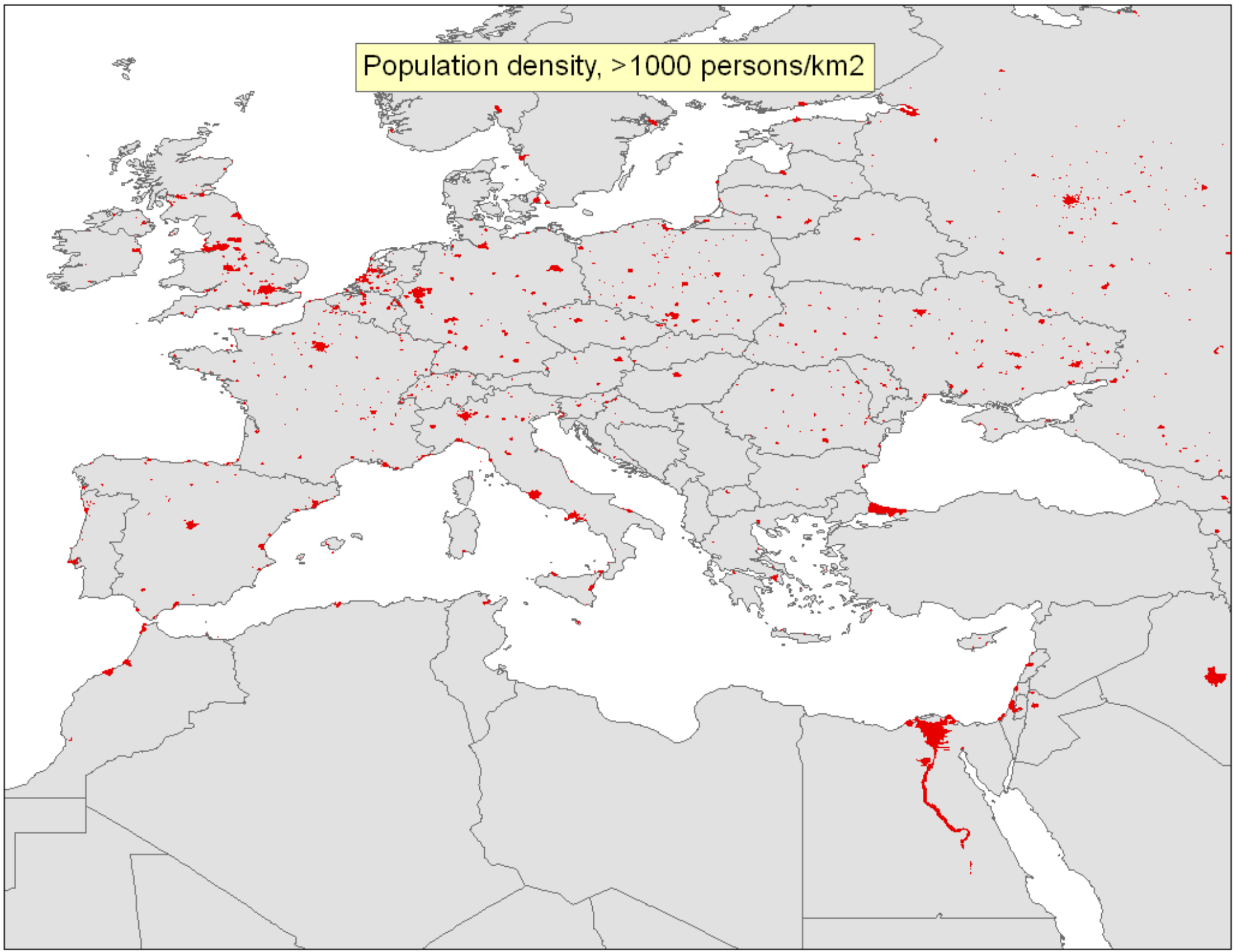- Temperate Evergreen Forest
- Marine West-coast
- Tundra
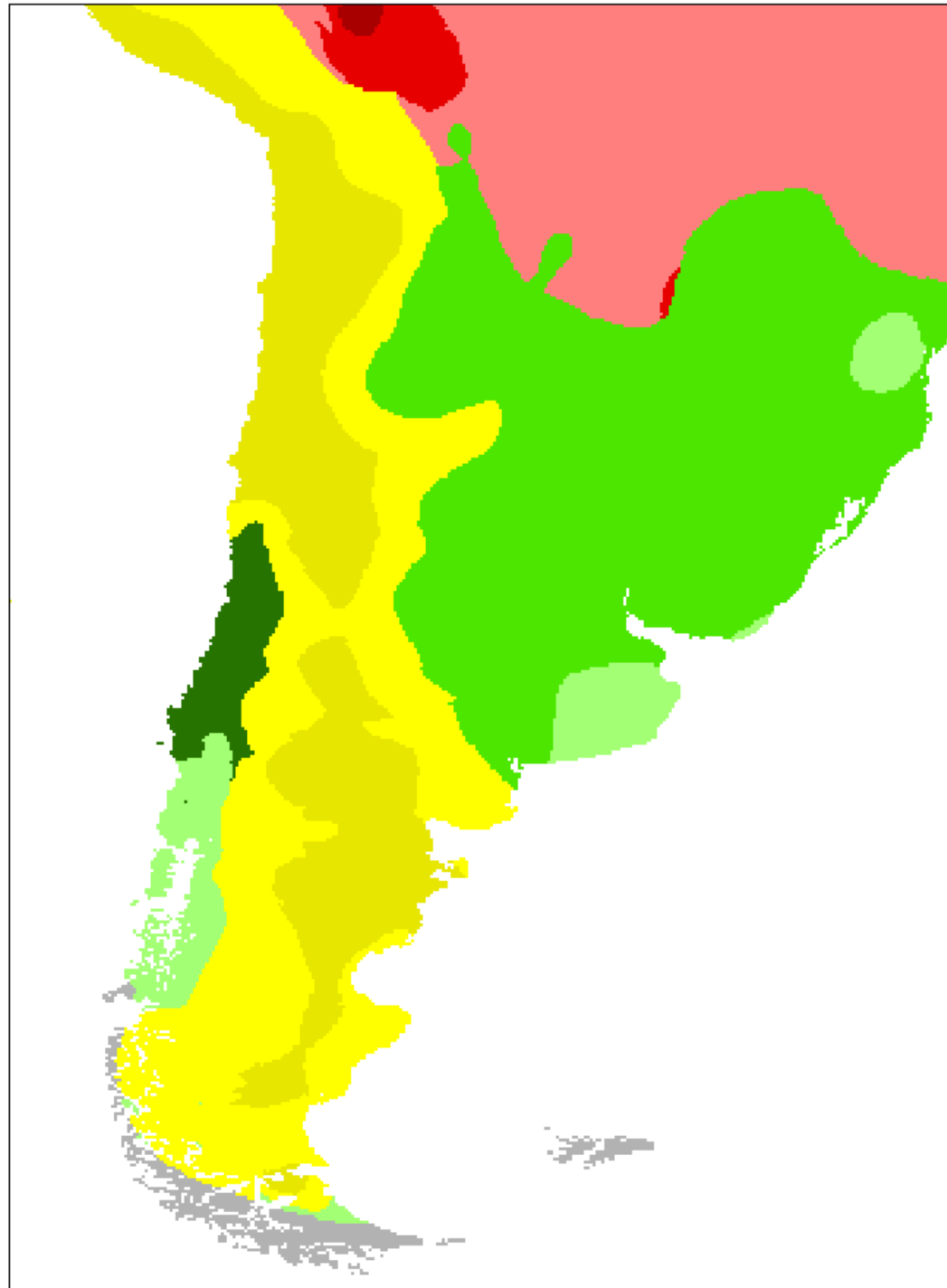
Population density, >5 persons/km2
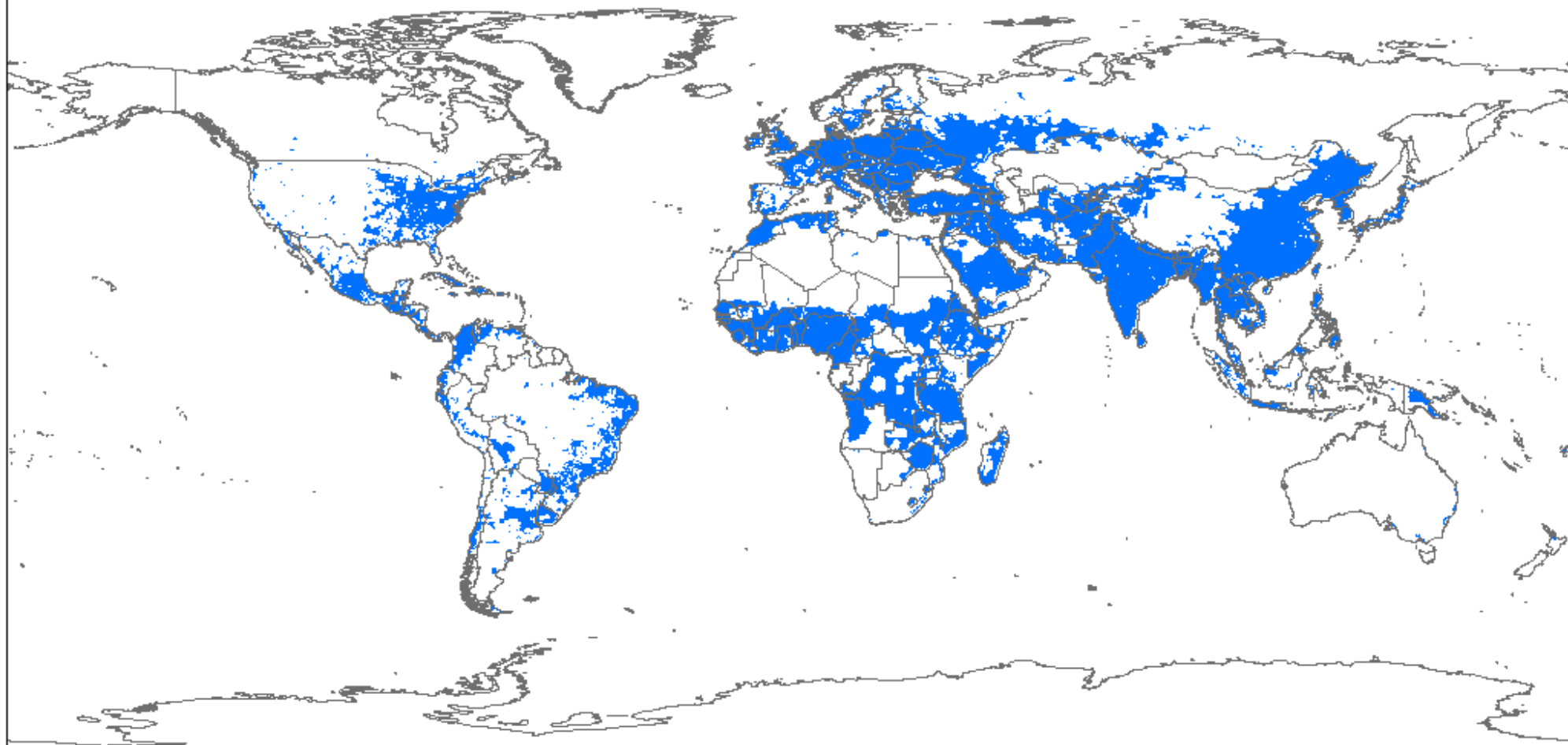
Population density, >1000 persons/km2

Final strata

Tropical Rainforest
Tropical Seasonal Forest
Tropical Savannah
Desert
Steppe
Mediterranean
Temperate Evergreen Forest
Marine West-coast
Tundra
pTropical Rainforest
pTropical Seasonal Forest
pTropical Savannah
pDesert
pSteppe
pTemperate Evergreen Forest
Urban

Legend

Tropical Rainforest	Mediterranean	Cold Boreal Forest	pSteppe
Tropical Seasonal Forest	Temperate Evergreen Forest	pTropical Rainforest	pTemperate Evergreen Forest
Tropical Savannah	Marine West-coast	pTropical Seasonal Forest	pContinental Forest
Desert	Continental Forest	pTropical Savannah	Urban
Steppe	Boreal Forest	pDesert	
			Tundra
			Snow and Ice

Distribution of MODIS LC Classes
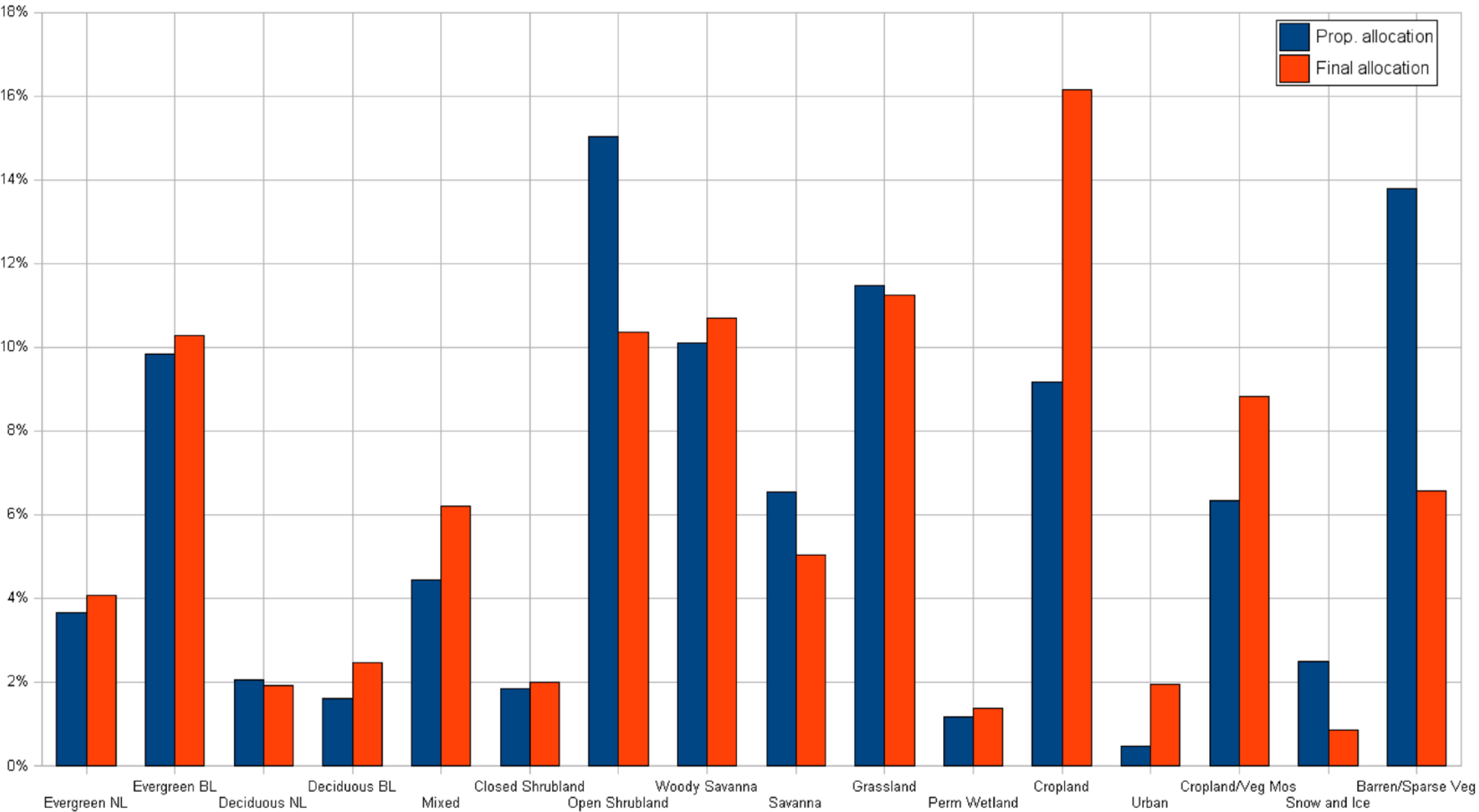
#	Final strata	Global cover	Prop all.	Final all.
1	Tropical rainforest	2.4%	12	10
2	Tropical seasonal forest	2.0%	10	10
3	Savannah	5.0%	25	15
4	Desert	14.4%	72	20
5	Steppe	8.3%	41	20
6	Mediterranean	1.6%	8	25
7	Temp. evergreen forest	1.2%	6	25
8	Marine west-coast	1.6%	8	25
9	Continental forest	4.3%	22	30
10	Boreal forest	12.7%	63	50
11	Cold boreal forest	1.2%	6	10
12	Tundra	3.3%	17	10
13	Frost	1.2%	6	0
14	pTropical rainforest	2.2%	11	15
15	pTropical seasonal forest	1.9%	10	10
16	pTropical savannah	11.0%	55	40
17	pDesert	6.0%	30	25
18	pSteppe	7.0%	35	35
19	pTemp. evergreen forest	5.2%	26	40
20	pContinental forest	6.7%	34	50
21	Urban	0.6%	3	35
	Sum	100%	500	500

"p" denots strata with >5 pers/km2.
"Prop. all." is the sample allocation proportional to the area of the strata.
"Final all." is the allocation that we decided.

Location of Sample Sites
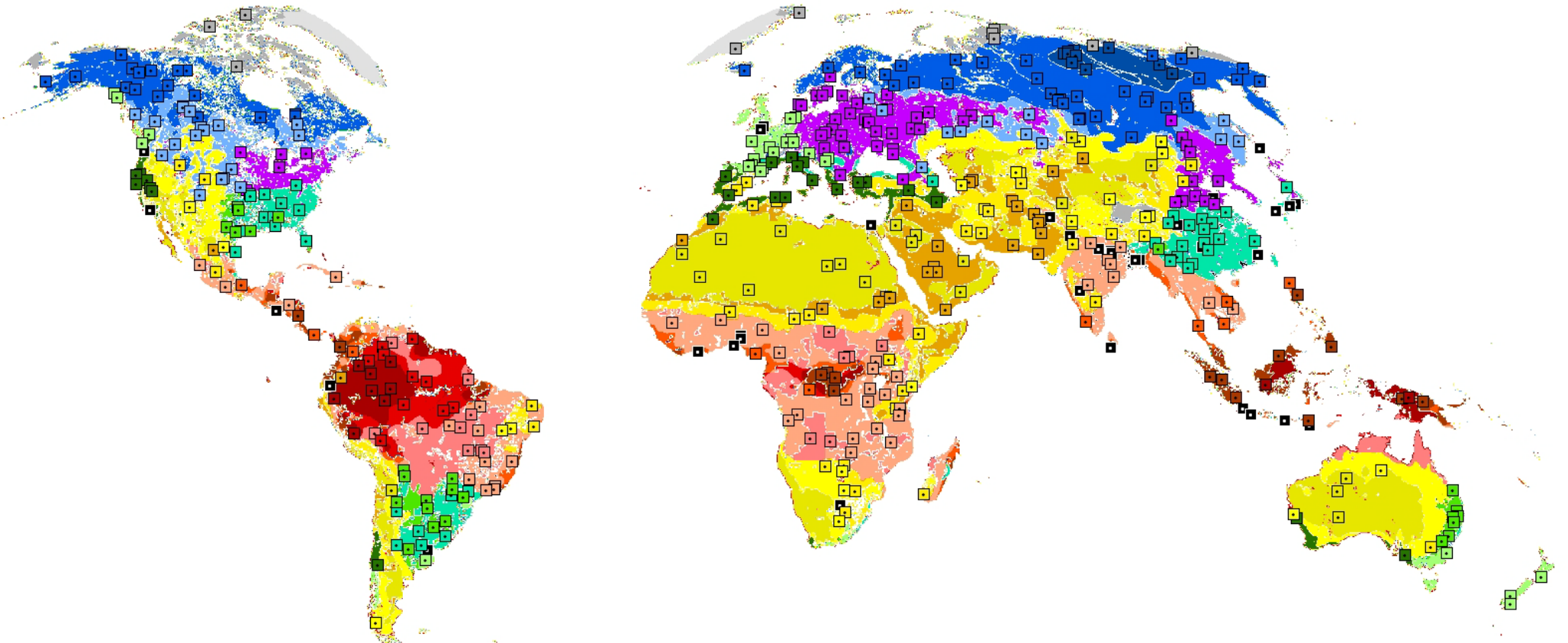
Color	Label	Color	Label	Color	Label	Color	Label	Color	Label
	Tropical Rainforest		Mediterranean		Tundra		pTropical Savannah		Urban
	Tropical Seasonal Forest		Temperate Evergreen Forest		Snow and Ice		pDesert		
	Tropical Savannah		Marine West-coast		Cold Boreal Forest		pSteppe		
	Desert		Continental Forest		pTropical Rainforest		pTemperate Evergreen Forest		
	Steppe		Boreal Forest		pTropical Seasonal Forest		pContinental Forest		

Response Design

LCCS-based legend (minimum required)

A. Tree

1. **Needleleaved**   **2. Broadleaved**   **3. Mixed**

a. *Evergreen*   a. *Evergreen*

b. *Deciduous*   b. *Deciduous*

B. Shrub

1.Needleleaved   **2. Broadleaved**

C. Herbaceous

1. Cultivated lands

2. Pasture

3. Tundra

4. Other

D. Urban (built)

E. Bare areas

F. Snow and ice (present > 11 mo/year)

G. Water (present > 11 mo/year)

H. Shadow

An Example of a Test site: SW USA

PJ   Bare Ground   Cottonwood   Riparian Grass   Shadow

Agriculture   Bedrock   Scrubland   River
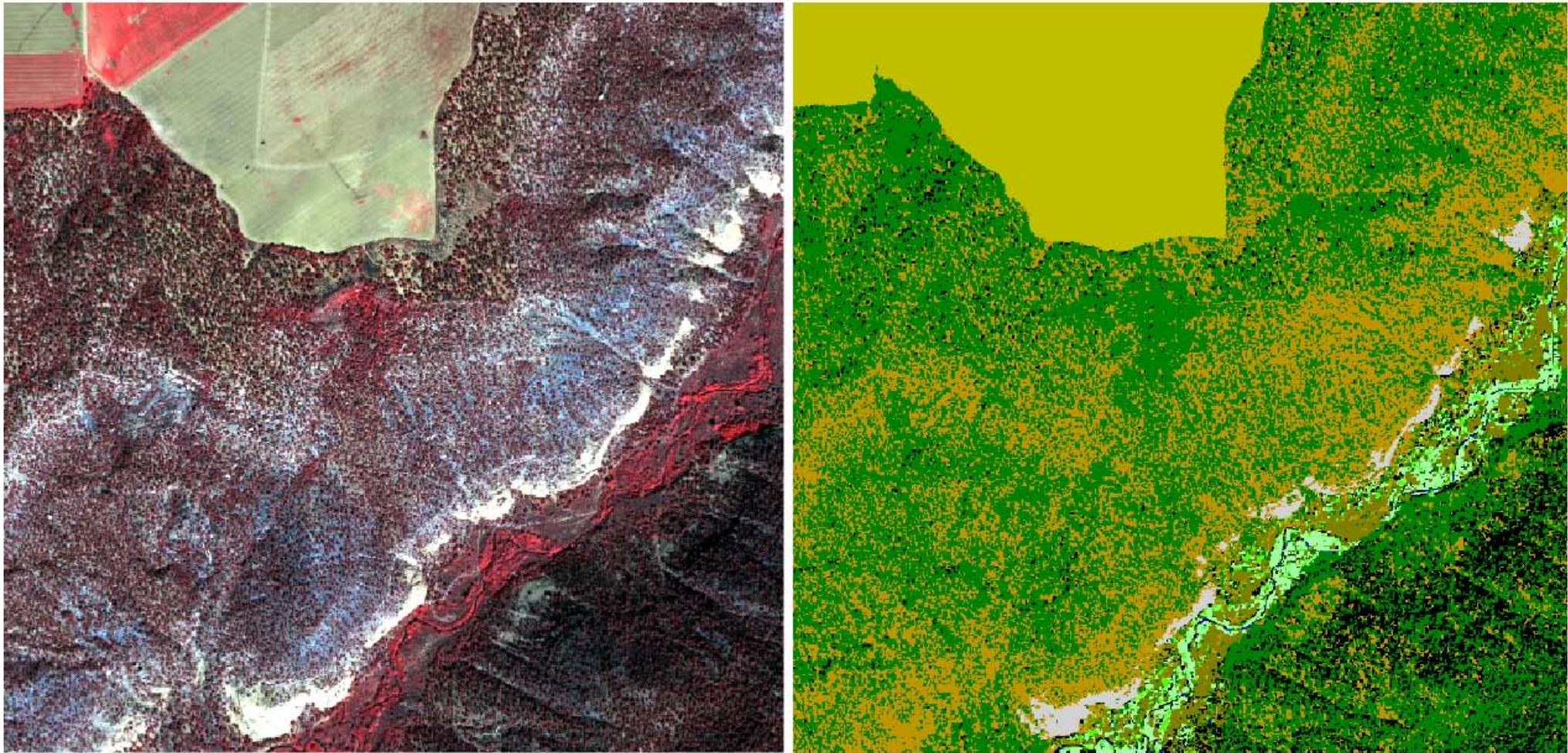
QuickBird image, NW Florida, Nov. 20th, 2009.

GlobCover land cover product (2005) overlaid.

Legend:
- Water
- Closed-open grassland
- Mosaic forest - shrub/grassland
- Closed-open mixed BL/NL
- Closed NL evergreen
- Open BL deciduous
- Closed BL deciduous
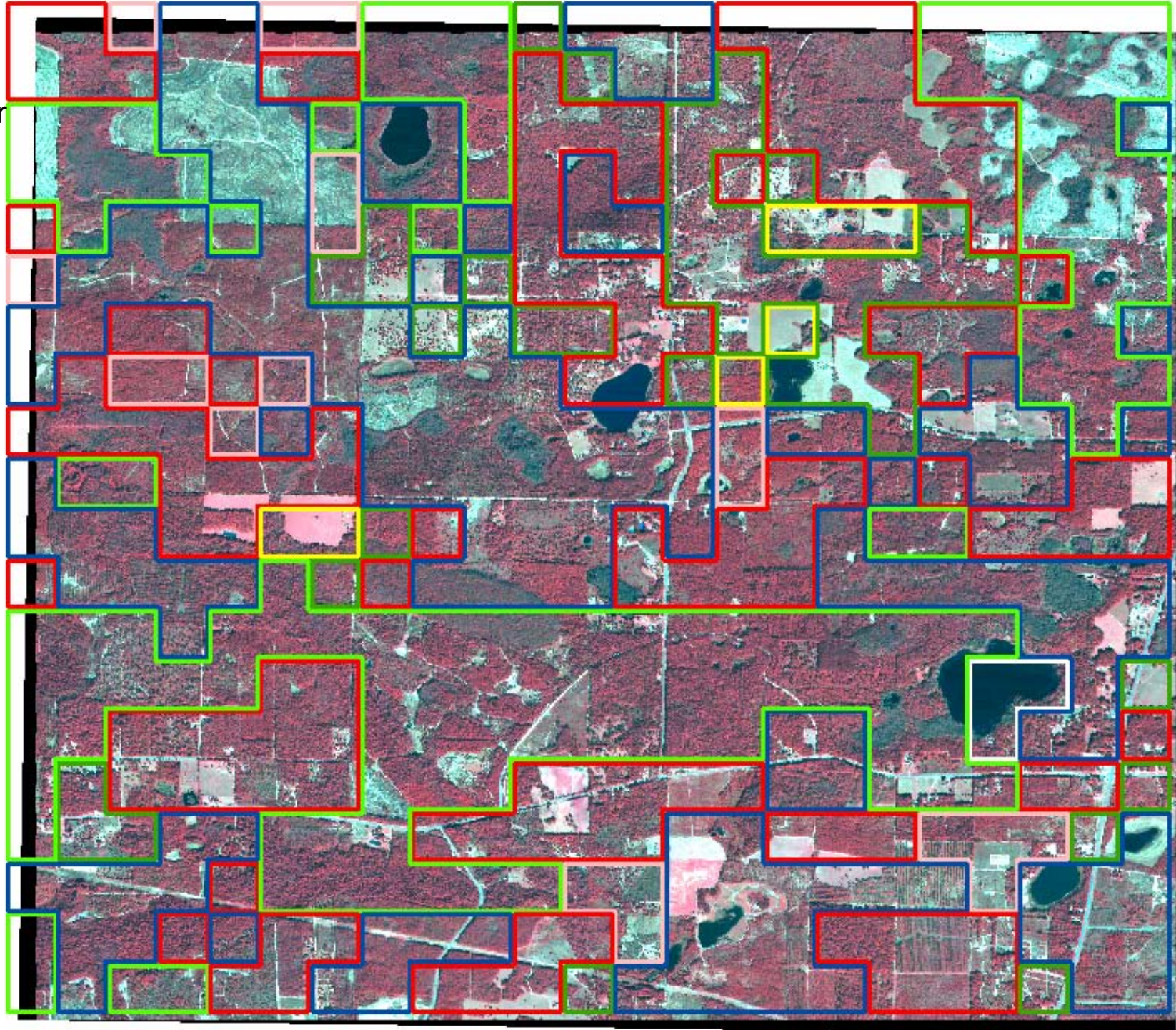
QuickBird image, NW Florida, Nov. 20th, 2009.

MODIS IGBP land cover product (2005) overlaid.

A blow-up

Evergreen Needleleaf Forest
Evergreen Broadleaf Forest
Deciduous Broadleaf Forest
Mixed Forest
Closed Shrubland
Woody Savannas
Permanent Wetlands
Croplands
Cropland/Natural Vegetiation Mosaic
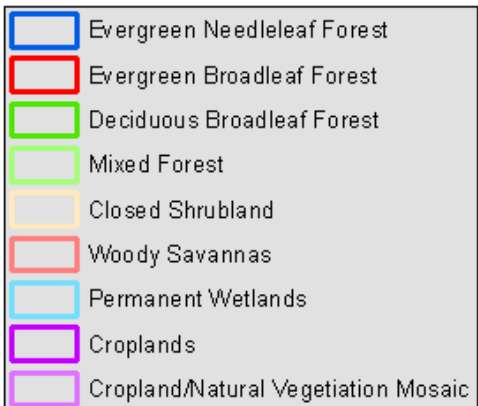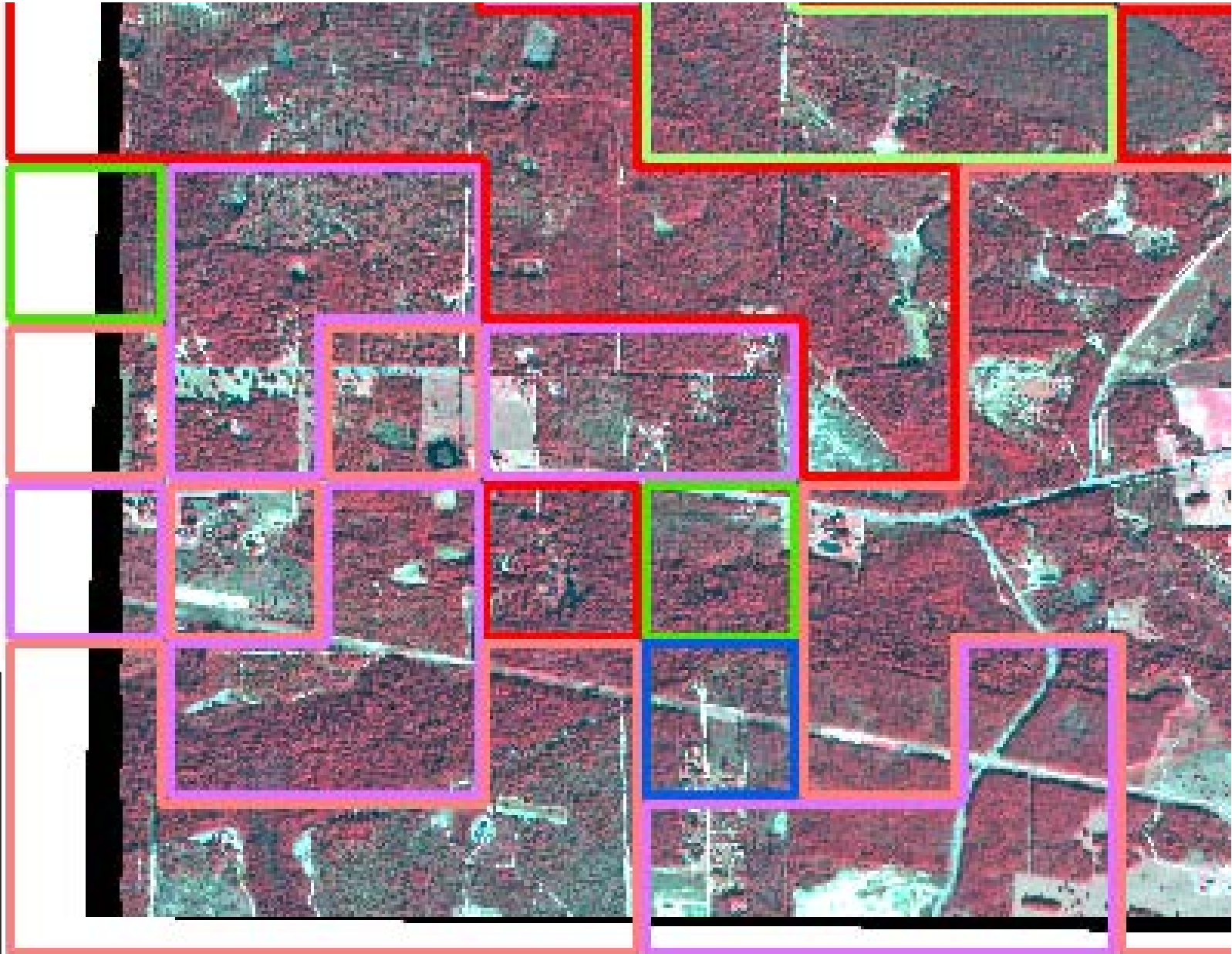
QuickBird image, NW Washington, Oct. 26th, 2007.

MODIS IGBP land cover product (2005) overlaid.

	Evergreen Needleleaf Forest
	Deciduous Needleleaf Forest
	Deciduous Broadleaf Forest
	Mixed Forest
	Closed Shrublands
	Woody Savannas
	Permanent Wetlands
	Urban and Built-Up
	Cropland/Natural Vegetation Mosaic
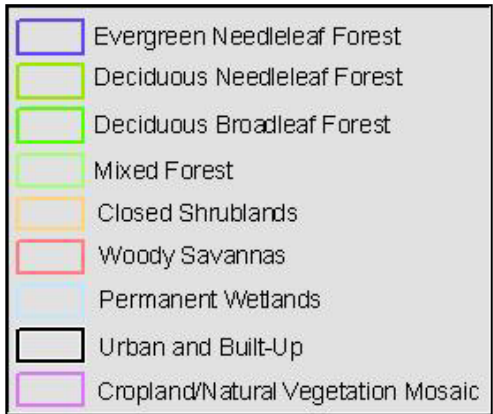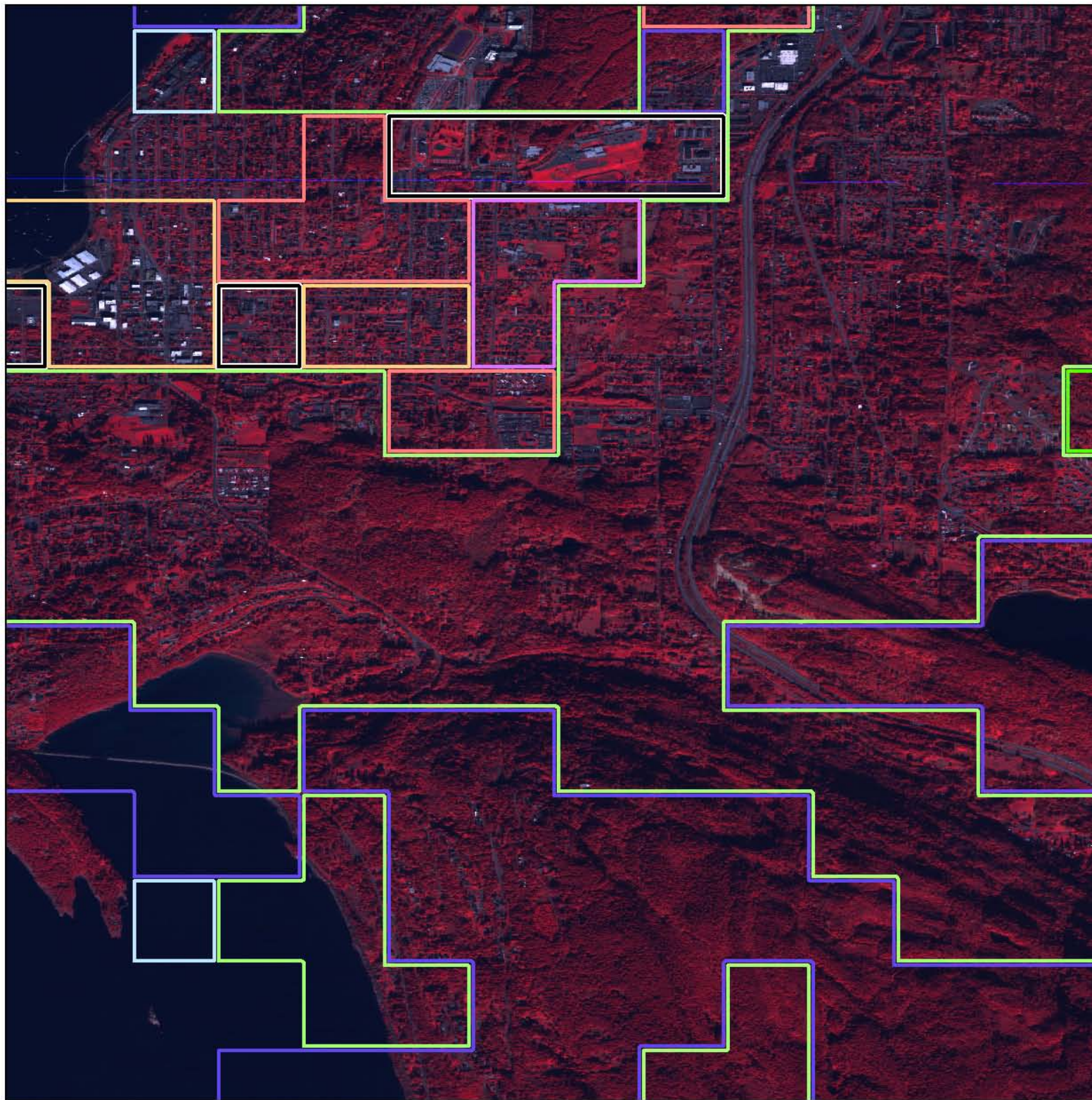
QuickBird image, NW Washington, Oct. 26th, 2007.

GlobCover land cover product (2005) overlaid.

Closed BL deciduous
Closed NL evergreen
Closed to open mixed BL/NL
Sparse veg
Closed-open BL forest regularly flooded
Artificial area
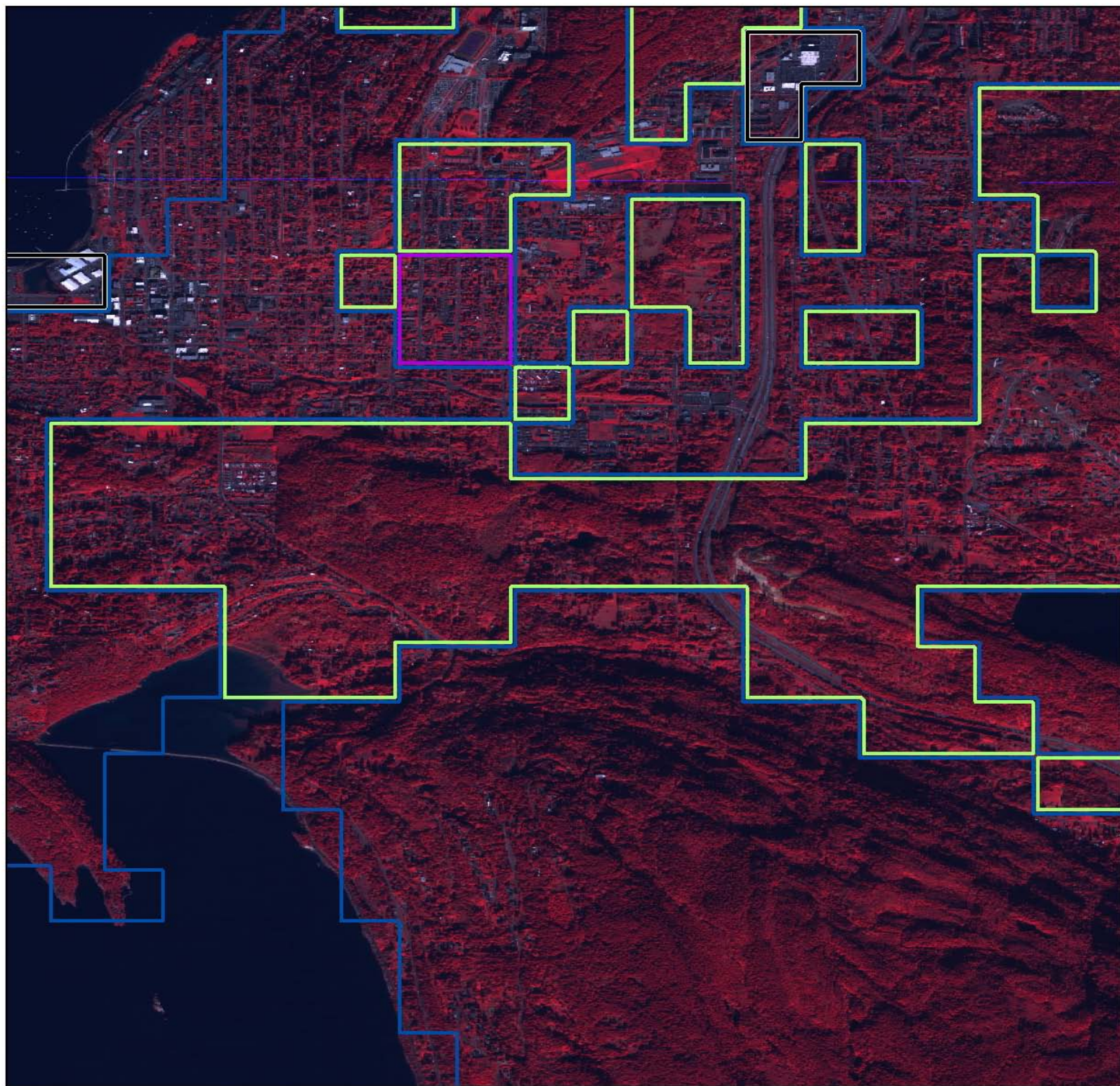
Next Steps

- Finish analysis of stratification (efficiency)
- Finalize Response Design
- Start doing test sites (we have imagery for 6 sites in NA)
- Continue Workshops to solicit help from local experts