

IGOL and Socio-economic variables

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FAO

Relation to socio-economic theme

- Focus on limited proportion of socio-economic variables
- Population distribution
- Urban areas
- Land Use
- Transportation infrastructure

High Priority Products

- *Population density – ambient and residential.*
- *Bounding polygons for cities, towns, villages.*
- *Urban landuse classes (e.g. low density residential).*
- *Vectors for streets and roads.*
- *3-D models of urban centers.*
- *Impervious surface area.*
- *Living conditions (e.g. extent of electrification, poverty).*
- *Spatial distribution of fossil fuel trace gas and aerosol emissions.*
- *Spatial distribution of economic activity (e.g. GDP).*

Periodic Updates Required For All Products

Satellite Remote Sensing Observables Unique To Developed Areas

- *Physical infrastructure*
- *Nocturnal lighting*
- *Electrical emissions*
- *Combustion point sources – from large gas flares, other industrial sources and down individual dwellings*

Satellite Remote Sensing Observables For Developed Areas

Observable	Current System(s)	Adequacy	Planned Systems	Adequacy
Infrastructure (spatial & 3-D)	IKONOS Quickbird others	Observational capability adequate, global collections required on human settlements.	Commercial systems - TBD	Observational capability adequate, global global collections required on human settlements.
Infrastructure (spectral)	Landsat, ASTER. Ikonos, Quickbird, MODIS, others	Mixed pixel problems with 30+ meter data. Global archives required.	Landsat 8?, VIIRS and others	Observational capability adequate, global archive required.
Combustion point sources	Nighttime Landsat, ASTER SWIR, Hyperion	Little nighttime Landsat acquired – ASTER SWIR bands typically not collected at night. Value unproven.	TBD	TBD
Nighttime Lights	DMSP-OLS	Coarse spatial resolution – poor calibration.	VIIRS-DNB	Improvement over OLS – but falls short on spatial resolution and performance TBD.
Electrical Emissions	None	Value unproven	TBD	TBD



Visible

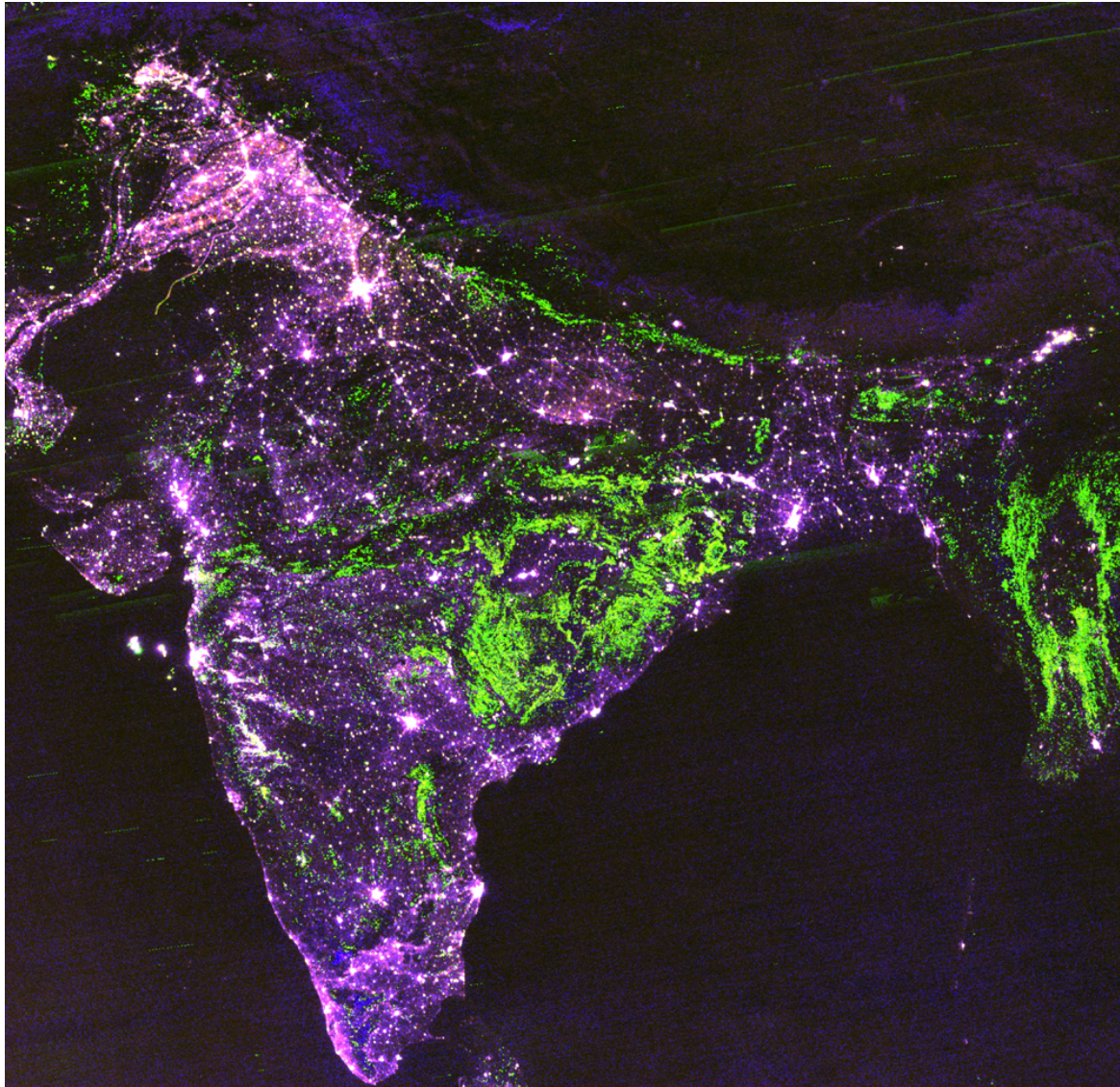


Thermal

The U.S. Air Force
Defense Meteorological
Satellite Program (DMSP)
Operational Linescan
System (OLS) has a
Unique capability to
collect low-light imagery.

Polar orbiting
3000 km swath
2.7 km ground sample
distance (GSD)
Two spectral bands:
visible and thermal
Nightly global coverage
Flown since 1972
Will continue till ~2012

What do a billion people look like?



DMSP F-10 OLS
cloud-free composite
from 1993.

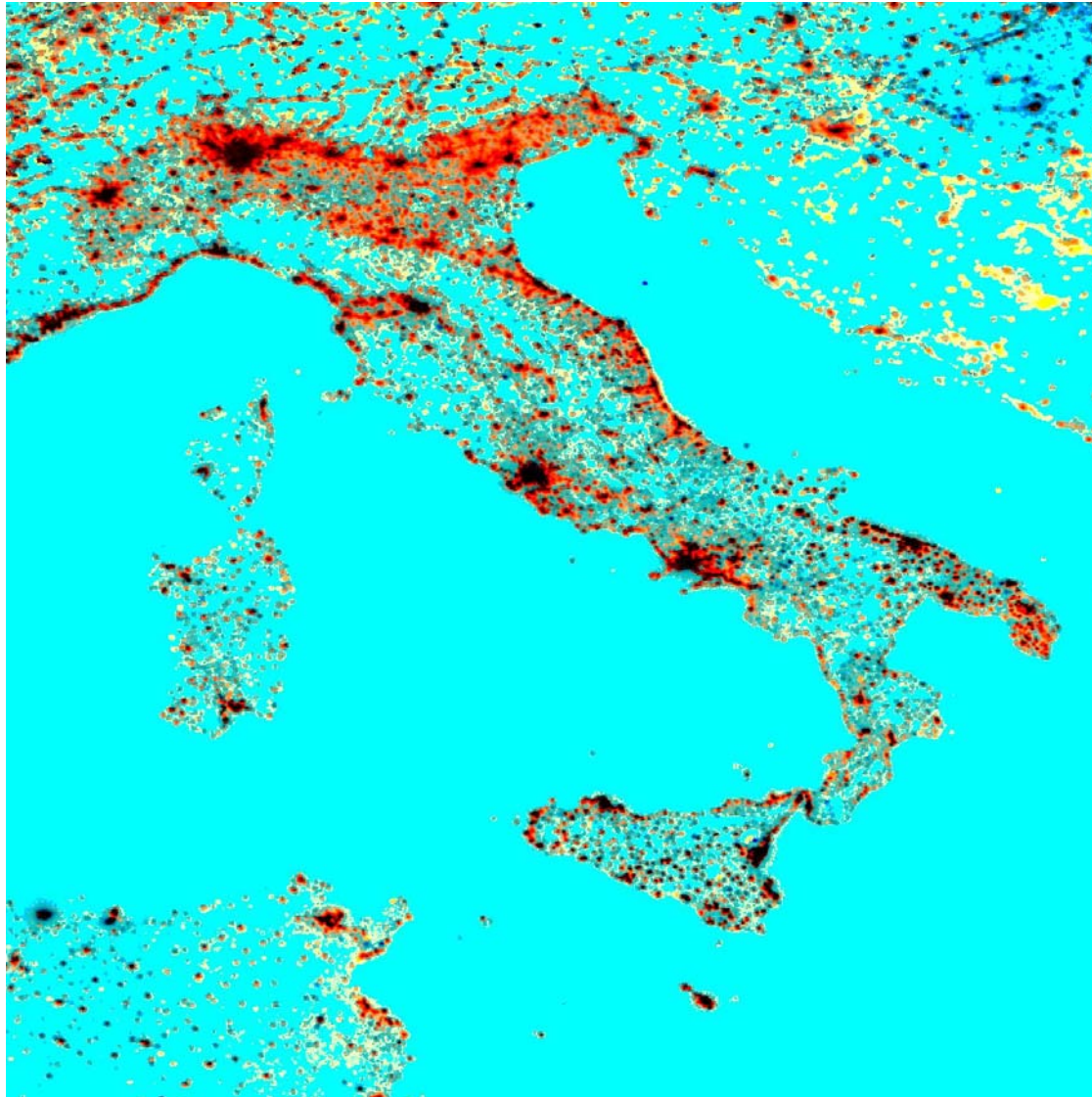
Average visible band
value = red.

Maximum visible
band value = green.

Minimum visible
band value = blue.

Nighttime Lights Change Detection (1992-93 versus 2000)

Italy and surroundings



Red: Lights brighter in 2000

Yellow: New lights in 2000

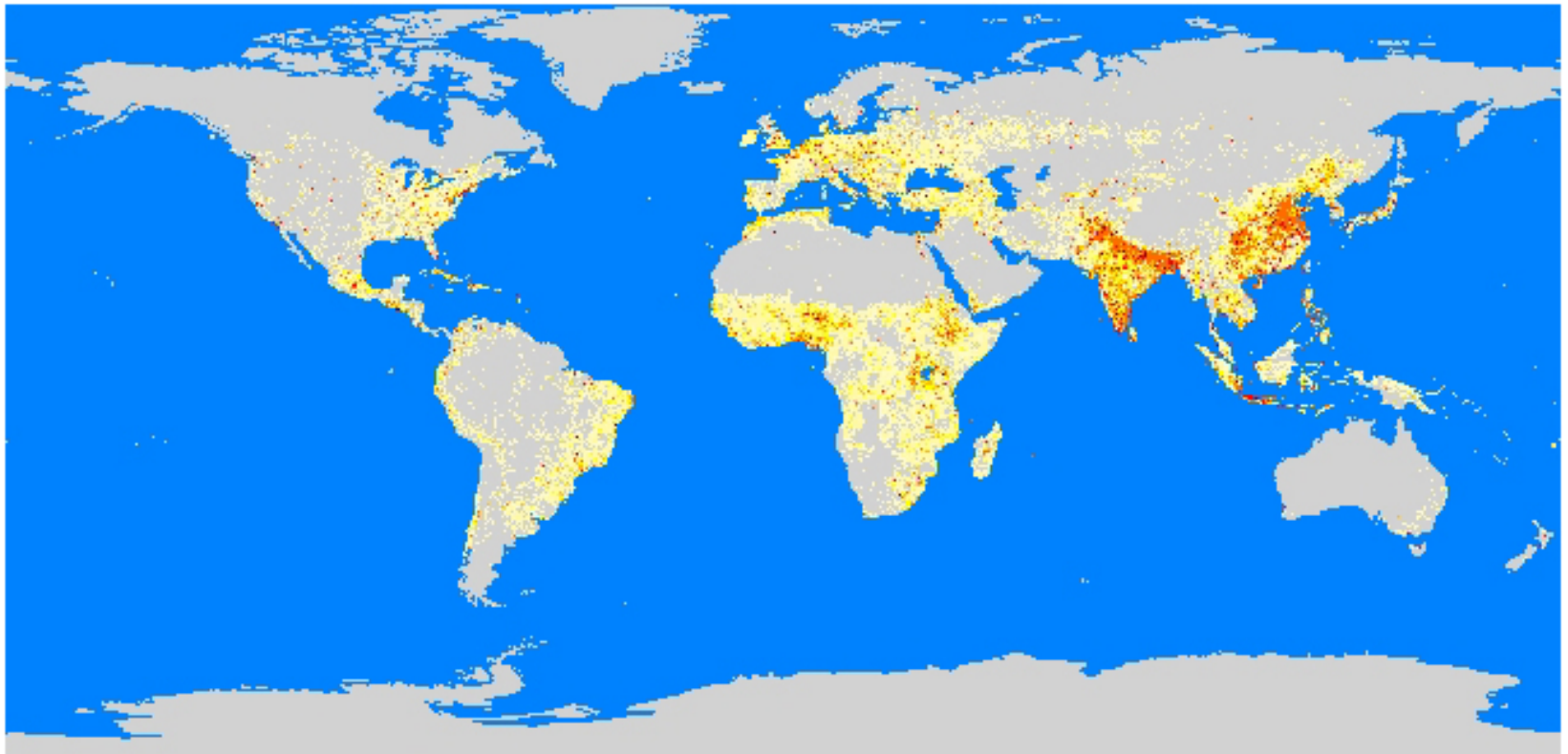
Blue: Lights brighter in
1992-93

Blue/Grey: Dim lights
detected in both years

Black: Lights Saturated in
both periods

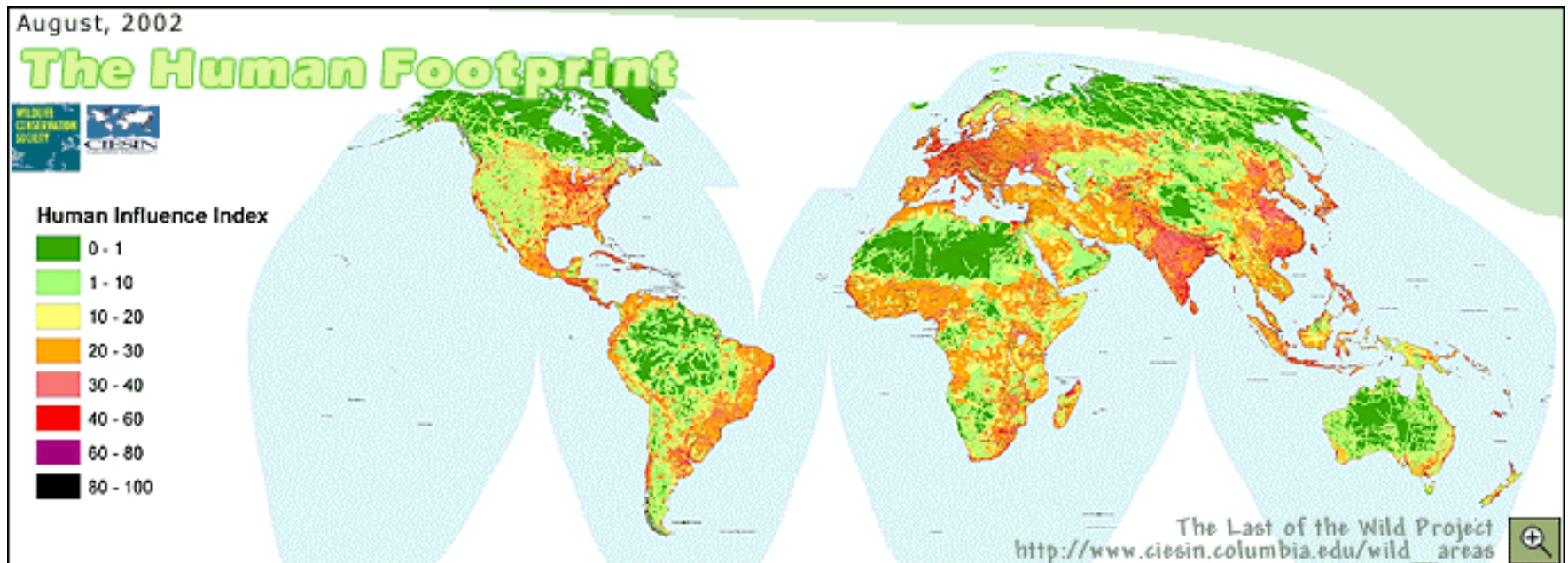
LandScan Uses Nighttime Lights and Other Data Sources To Model Global Ambient Population

<http://www.ornl.gov/sci/gist/landscan/index.html>

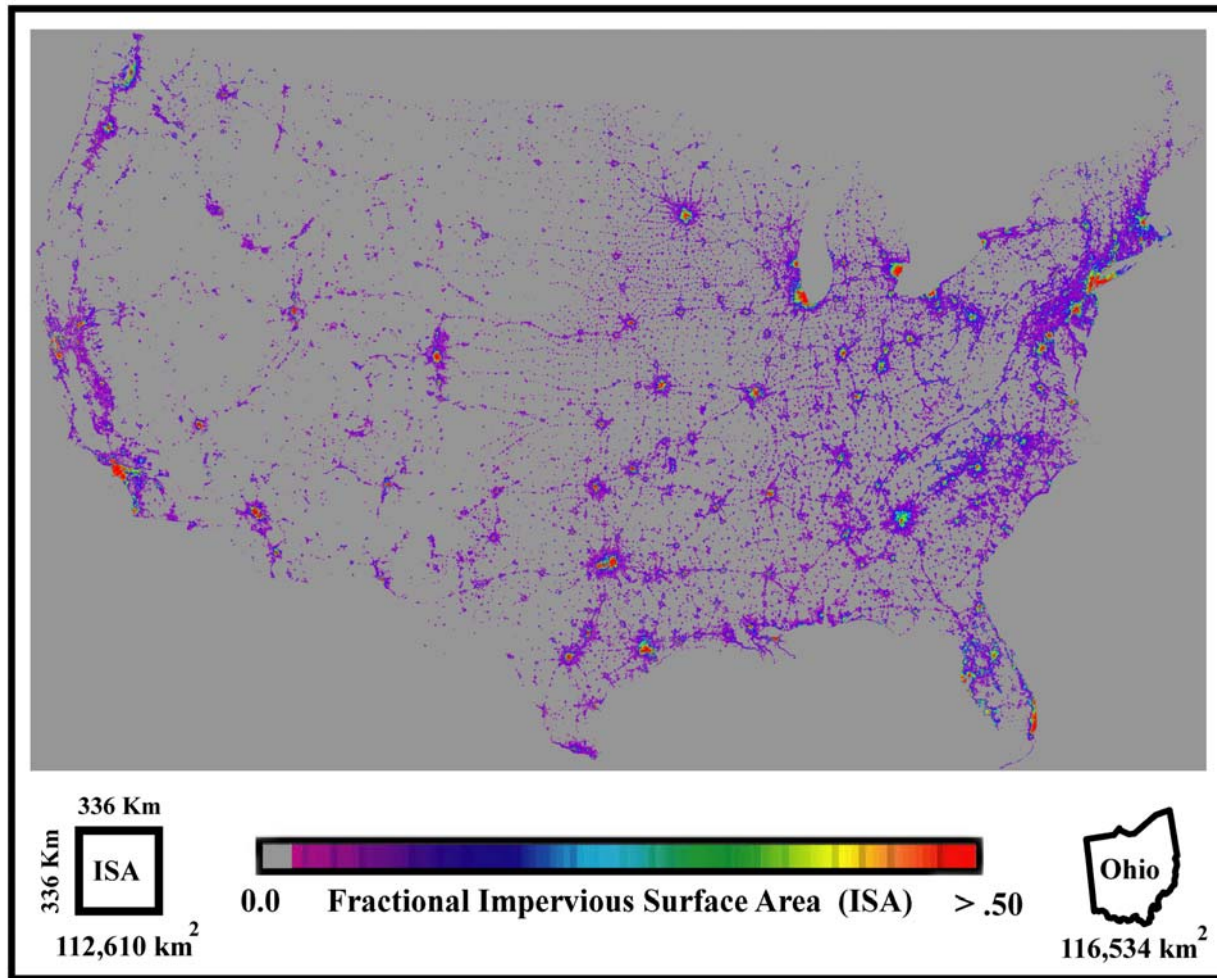


The Human Footprint Dataset Uses Nighttime Lights and Other Data Sources

http://www.ciesin.columbia.edu/wild_areas/



The year 2000 constructed impervious surface area (ISA) of the USA is nearly the size of Ohio



One km² ISA grid used the following data inputs:

- 1) Nighttime lights (NOAA)
- 2) Road density (Census Bureau)
- 3) Landsat urban land cover (USGS)
- 4) Calibrated using commercial aerial photography

ISA grid downloaded 308 times during June and July, 2004.

Reference: Elvidge, C.D., Milesi, C., Dietz, J.B., Tuttle, B.T., Sutton, P.C., Nemani, R., Vogelmann, J.E., 2004, U.S. constructed area approaches the size of Ohio. EOS Transactions, American Geophysical Union, v. 85, p. 233.

Anticipated Improvements From VIIRS Day/Night Band (DNB)

- Improved spatial resolution (0.8 km)
- On-board calibration
- Will cover OLS dynamic range with automatic gain changes to avoid saturation and higher level of quantization.
- In-scene discrimination of lights and fires.
- Improved cloud and snow detection.

How Does the VIIRS DNB Fall Short?

- Detection limits designed to match OLS – detection of dimmer lighting not anticipated.
- Panchromatic – no spectral information on lighting type.
- Spatial resolution remains relatively coarse.
- Performance of the DNB TBD.

NightSat Concept

Demographers, geographers, social scientists, economists and ecologists currently working with DMSP-OLS nighttime lights data are dissatisfied with the OLS' coarse spatial resolution, saturation of urban centers and lack of calibration. Technology exists for a NightSat sensor:

- Objective – annual global cloud-free nighttime lights composites far exceeding the quality of the OLS products and future VIIRS products.
- Pan-chromatic or multispectral low light imaging at 100 meter (or less) spatial resolution with on-board calibration.
- Approximately 200 km swath (similar to Landsat).
- Lower detection limits / wider dynamic range than OLS and VIIRS for detection of sparser / dimmer lighting while avoiding saturation in urban centers.
- SWIR band for fire detection or possibly fly in constellation with MODIS/VIIRS.
- Thermal band for cloud detection or possibly fly in constellation with MODIS/VIIRS.

Summary of Issues relating to Direct Observations of Settlements

- ***High spatial resolution imagery:*** Systems need to collect on human settlements - producing a global archive. Consolidated effort would be required to generate databases for streets and roads, impervious surfaces, 3-D urban models.
- ***Medium resolution multispectral (30 m to 1 km):*** Continuity of observations appears assured. Global urban landuse products from Landsat style data could be expedited based on nighttime lights to reduced data volume to be processed.
- ***Nighttime lights:*** VIIRS will provide data for improved products. Observations of nighttime lights could be substantially improved over DMSP-OLS and VIIRS with a dedicated sensor using existing technology.
- ***Electrical Emissions:*** Unexplored to date.



FAO component of the Poverty and Food Insecurity Mapping Project

Lead FAO Unit: SDRN

Other main partners: IIASA, CIESIN



Project Funding: Government of Norway and FIVIMS

The Poverty and Food Insecurity Mapping Project has three components implemented by 9 partners:

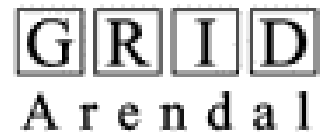
➤ **COMPONENT 1: Country Case Studies**
(Task Managers: 7 CGIAR Centers: CIAT, CIMMYT, IFPRI, IITA, ILRI, IRRI, IWMI)



➤ **COMPONENT 2: Global Analyses and Databases** (Task Manager: FAO/SDRN)



➤ **COMPONENT 3: Outreach and Dissemination of the Results** (Task Manager: UNEP-GRID-Arendal)



www.povetymap.net

The seven country case studies done by the seven CGIAR

Centers:

1. CIAT: Ecuador
2. CIMMYT: Mexico
3. IFPRI: Malawi
4. IITA: Nigeria
5. ILRI: Kenya
6. IRRI: Bangladesh
7. IWMI: Sri Lanka

The main objective of the FAO component:

DEVELOPMENT OF THE FIVIMS GLOBAL GIS DATABASE (FGGD)

The FGGD is a GIS database and modeling framework for better understanding of the global poverty and food insecurity issues in *SPATIAL* and *ENVIRONMENTAL* contexts related to agricultural productivity and accessibility.

IN PARTICULAR, ...WE NEED TO KNOW WHERE THEY ARE IN RELATION TO:

- ◆ **Agroecological zones**
- ◆ **Marginal and productive lands**
- ◆ **Major crops and livestock production systems**
- ◆ **Market access**
- ◆ **Livelihood systems**

Poverty mapping: Two approaches

- *Bottom-up approach*: Using socio-economic data aggregated by administrative boundaries such as survey/census data
- *Top-down approach*: Using satellite imagery, existing global environmental maps and GIS models.



POVERTY MAPPING

GEOGRAPHY OF POVERTY
GEOGRAFÍA DE LA POBREZA
GÉOGRAPHIE DE LA PAUVRETÉ



The hierarchy of
the maps in FGGD

LEVEL 4:

Maps for analysis
of vulnerability:

Accessibility
Pixel Ag. Economic Value
Actual crop zones for 28 crops
Livestock production
Rural Population density
Population Density in 2015;
Subnational Nutrition Profiles,

GRID resolution:
5 arc-minutes

Vector data scale:
1: 5 million

LEVEL 3: Maps Based on Models:

Potential crop zones for 28 major crops
Agro-ecological Zones, Length of Growing Period
Pixel shares of 4 land-use classes: Croplands, Pasture,
Forest and Other Lands
Environmental Constraints, Multiple cropping zones

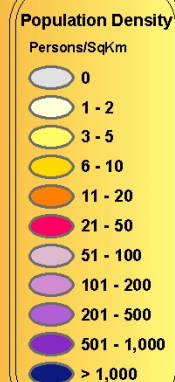
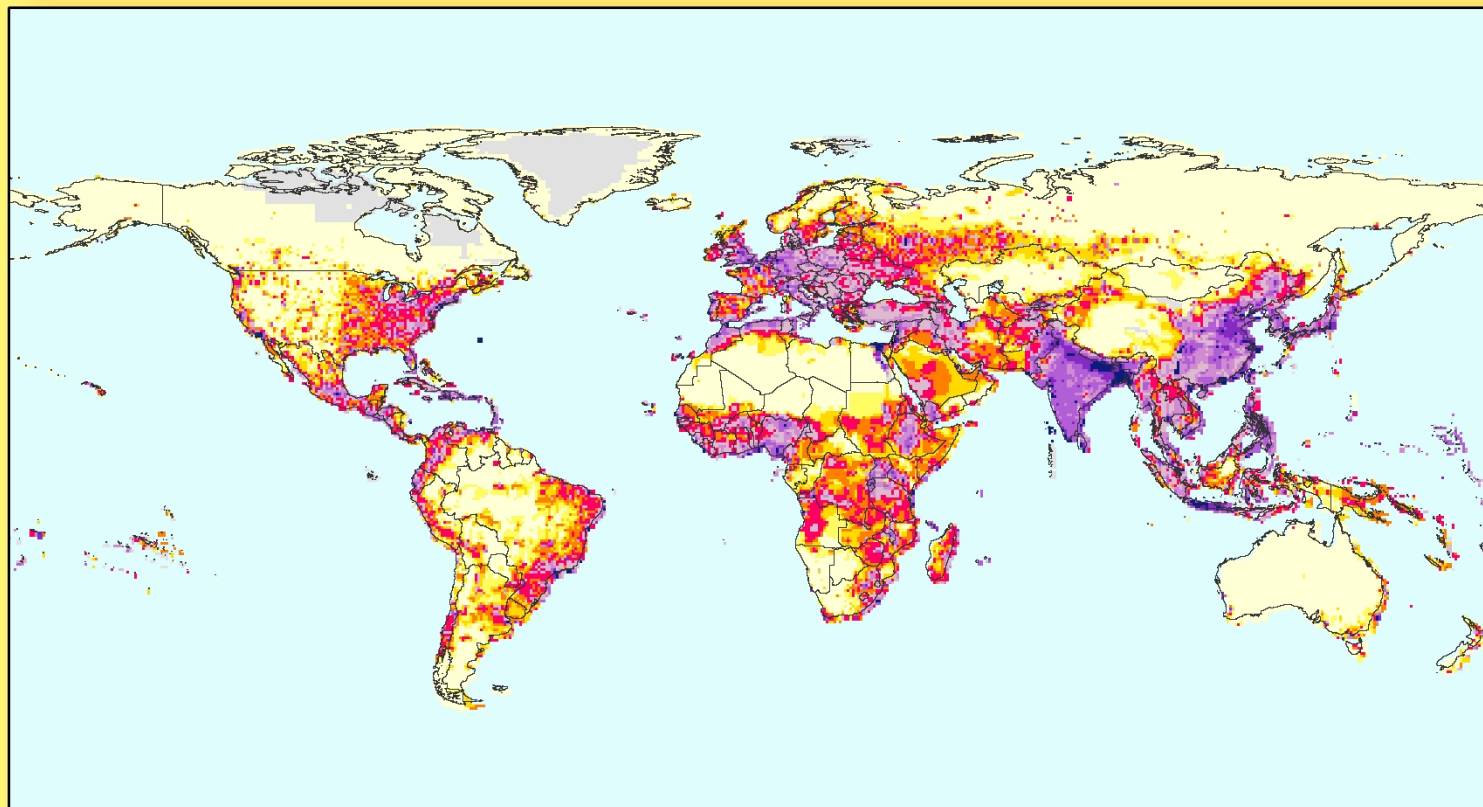
LEVEL 2: Primary data layers:

Soil and terrain properties, Farming system zones, Precipitation,
Temperature, Protected Areas, Irrigated Areas,

LEVEL 1: Base Maps:

Coastlines, DEM, National and Subnational Boundaries,

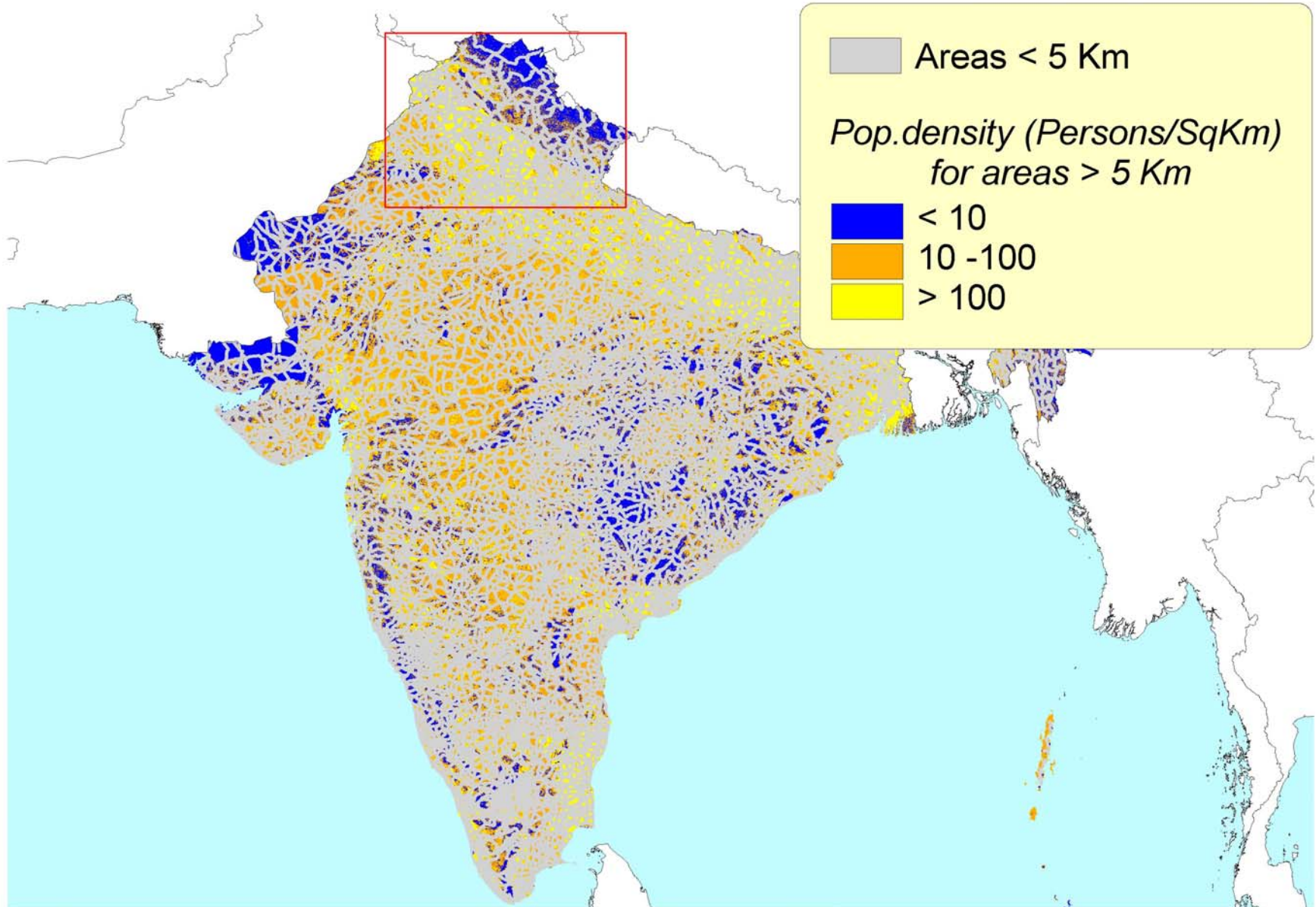
Global Population Density Projection for 2015



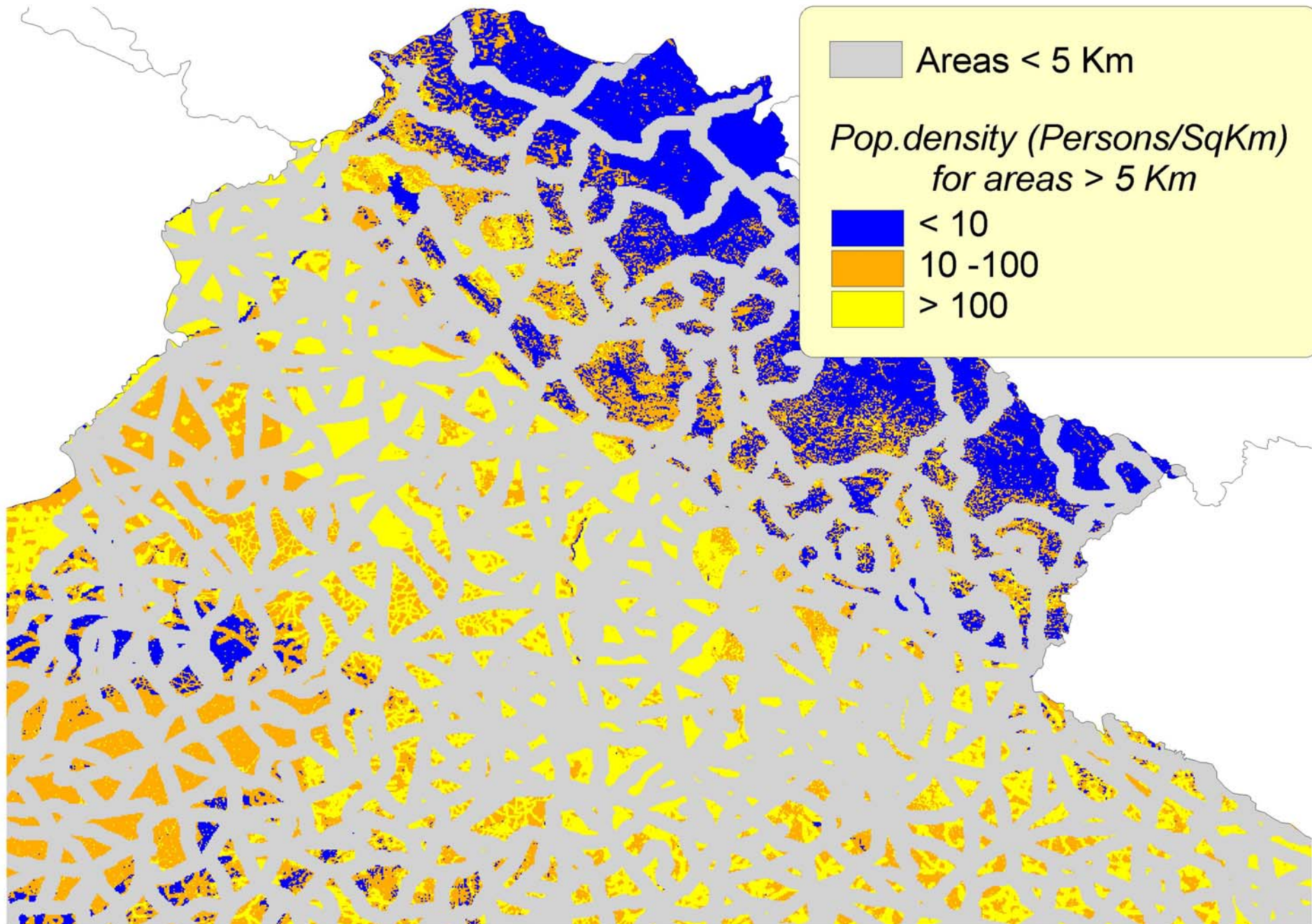
This map of gridded population in the year 2015 was derived from over 375,000 administrative units. Population is projected to the year 2015 using simple extrapolation methods: for most countries of the world, sub-national estimates of population from the two most recent censuses (c. 1990 and 2000) were used as the basis of the extrapolation. Sub-national rates of growth for the 1990-2000 interval were then applied, in five-year increments. At each step - 2005, 2010, and 2015 - national level totals were adjusted to United Nations' Population Estimates and Projections. (Due to the uncertainty arising from growth rates derived from high-resolution inputs, a growth rate cap of almost 5% was applied, where this is exceeded by sub-national growth.)

Acknowledgement
This document was prepared as part of the FAO Poverty Mapping Project (03/05/2003-2008) funded by the Government of Norway and with the support from the National Geographic Society and the Center for Global Change Science (CGCS) at the University of Massachusetts Lowell (Contract NAK-93117) to the Socioeconomic Data and Applications Center (SEDAC) at CIESIN.

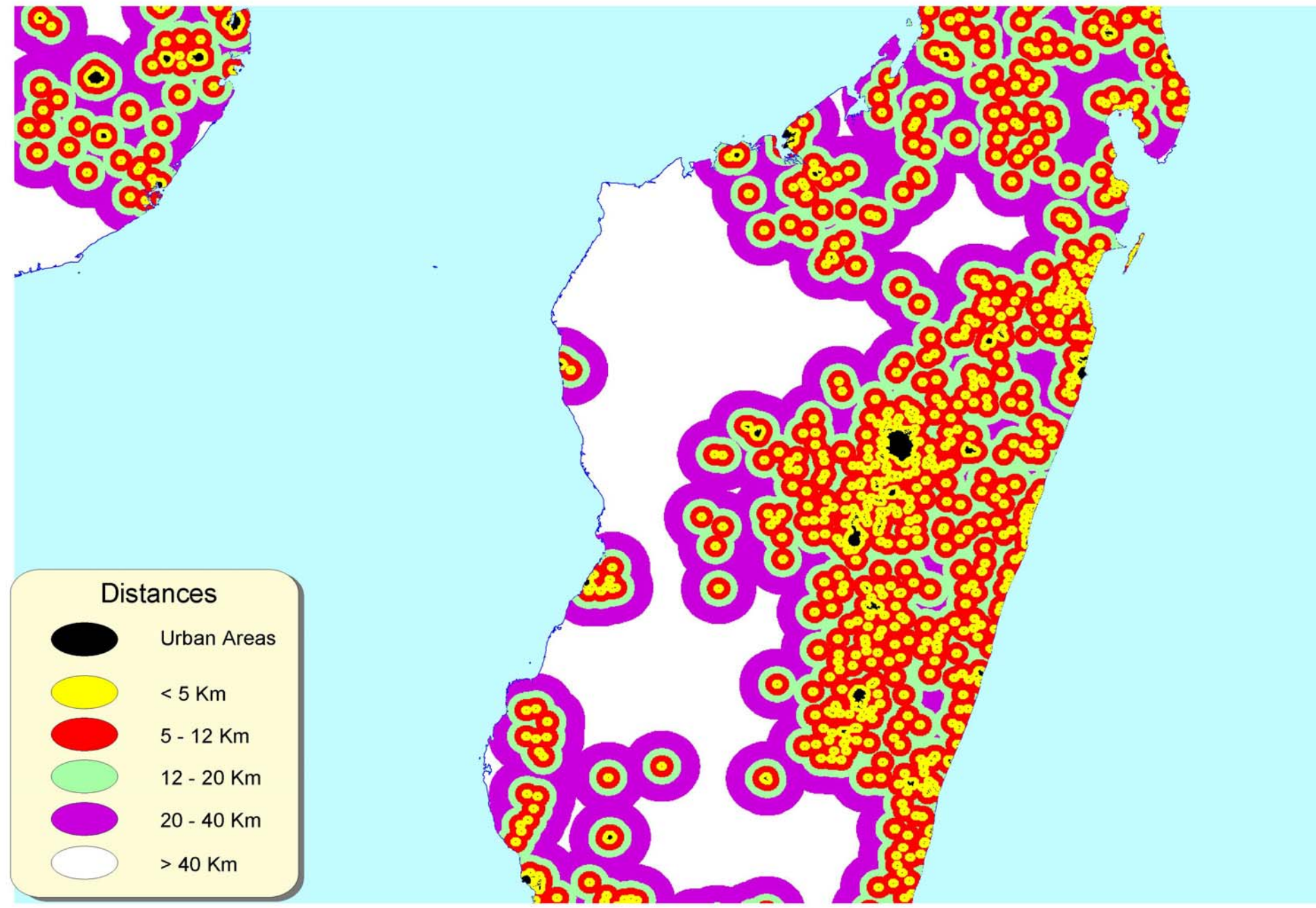
India: population density in areas > 5 km from roads



India: population density in areas > 5 km from roads

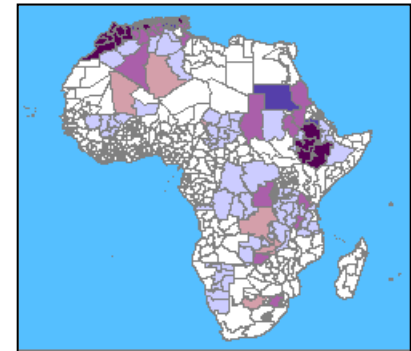
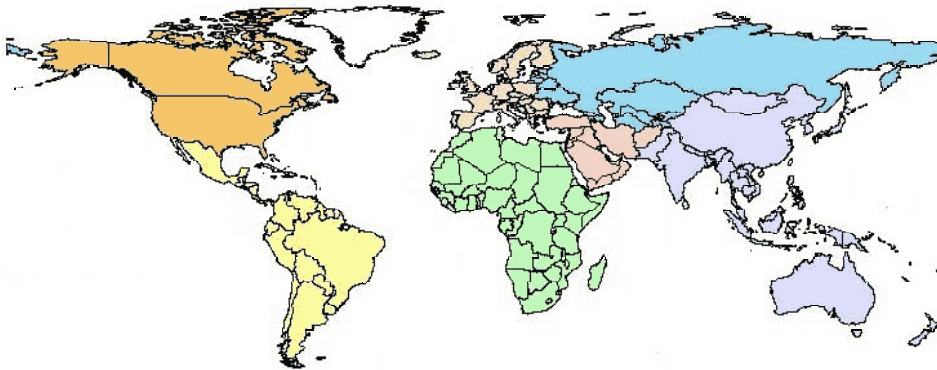


Accessibility: Distance to Markets



Agro-MAPS

A global spatial database on
sub national agricultural land-use statistics



Millennium Ecosystem Assessment

Why we need LU information

- Land resources are **finite & usually scarce!**
- **Competition** among various land uses (e.g. urban expansion into agricultural areas)
- Different land uses affect the natural equilibrium of ecosystems differently - dissimilar **impacts** on the sustainable flow of goods & services
- Thus, knowledge of current LU (& land resources) is needed for formulating **changes leading to sustainable use of the resources**

LU - Key input for planning & policy formulation

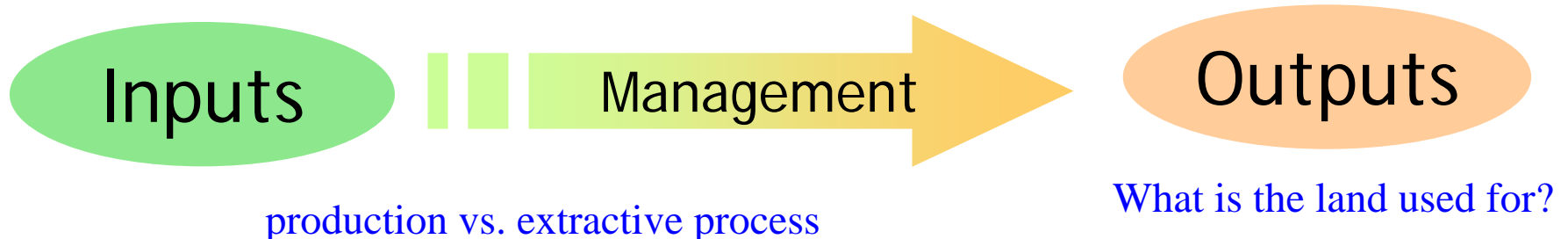
- **national regional/global scales**

Land use (LU)

“..human activities which are directly related to land, making use of its resources or having an impact on it ...”

FAO, 1995

- Socio-economic purpose of the activities (**functional** definition)
- Usually multiple purposes
- Manipulation of natural ecosystems in order to obtain **benefits**
- **Material** benefits/ products (e.g. cereals, livestock)
- **Immaterial** benefits/ services (e.g. erosion prevention)
- Often some unwanted impacts!!



Status of available data - 1

Regional/ global data

- Crops [FAOSTAT](#); [IFPRI](#)
- Forests [FAO \(FRA\)](#)
- Water [AQUASTAT](#), U. Kassel
- Cultivation intensity NASA
- Eco systems USGS
- Protected areas [UNEP-WCMC](#)
- Land cover/use [FAO\(Africover\)](#); [USGS](#); [IFPRI](#);
[SAGE](#); [LUCC](#); [MA](#); [GLC2000](#);
[Global Mapping](#);

Shortcomings: ± limited coverage / number of classes; non-standard definitions; insufficient information on management aspects; insufficient detail; modelled data

Status of available data - 2

Insufficient agricultural land use information needed to examine national, regional & global issues

TOPICAL ISSUES

- Food security & poverty
- Land degradation
- Climate change
- Policy formulation
- Land use planning
- Investments in sustainable agriculture
- ..



Millennium Ecosystem Assessment

Agricultural land use

How?

Management:
inputs, technologies

How much?

Quantities:
areas, products, ..

When?

Timing of
operations

What?

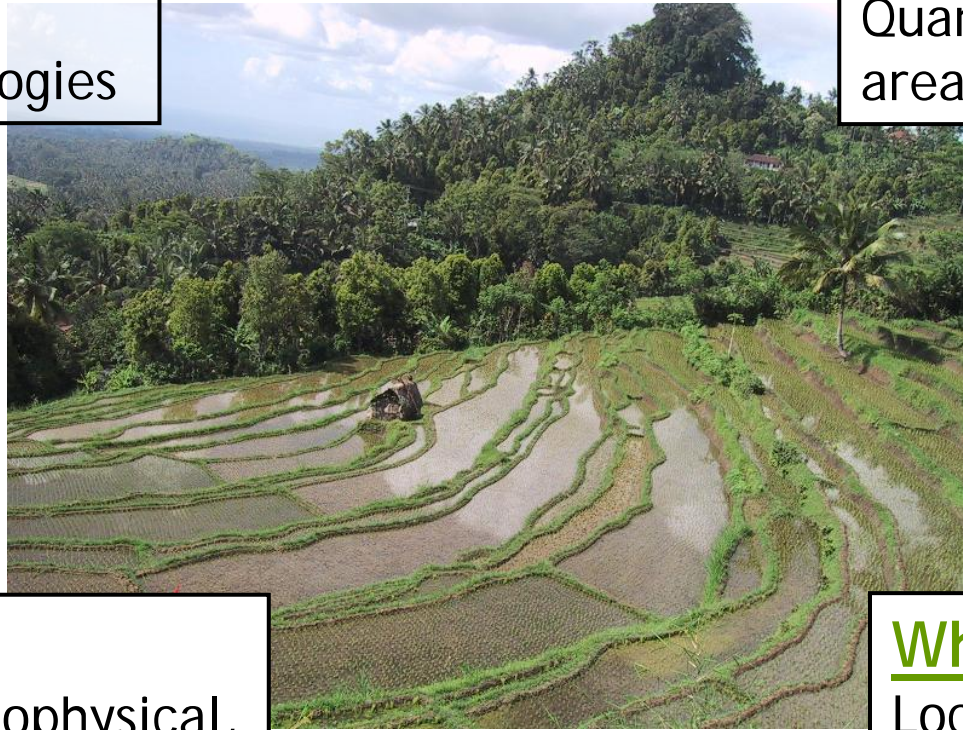
Objectives:
Products,
services

Why?

eg. reasons (biophysical,
socio-economic,..)

Where?

Location
& spatial extent



Major characteristics of agricultural land use

Versus Land cover... the observed (bio)physical cover on the earth's surface (LCCS, 2000)

Agro-MAPS database contents



Statistics aggregated by sub-national administrative districts.

- crop production
- area harvested
- crop yields

How much?

Quantities:
areas, products, ..

What?

Objectives:
Products,
services

Where?

Location
& spatial extent

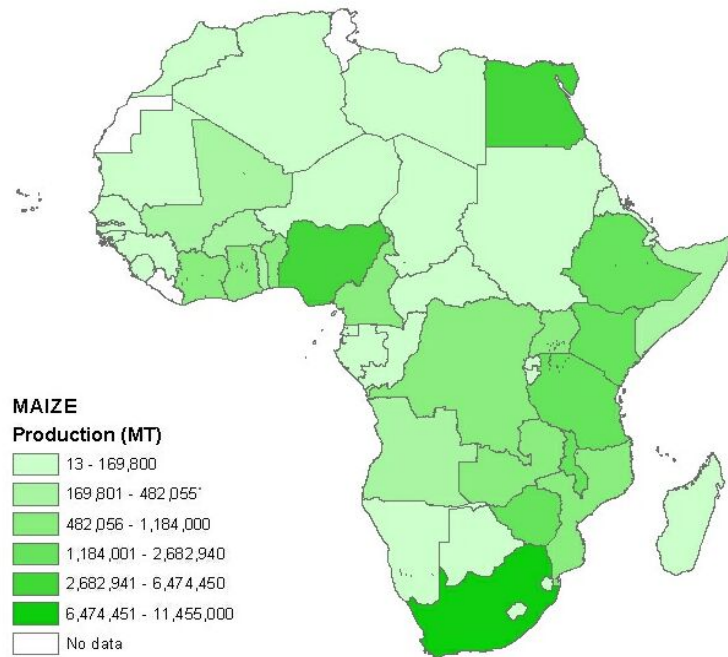
Major contents of the Agro-MAPS database

Subnational vs national statistics

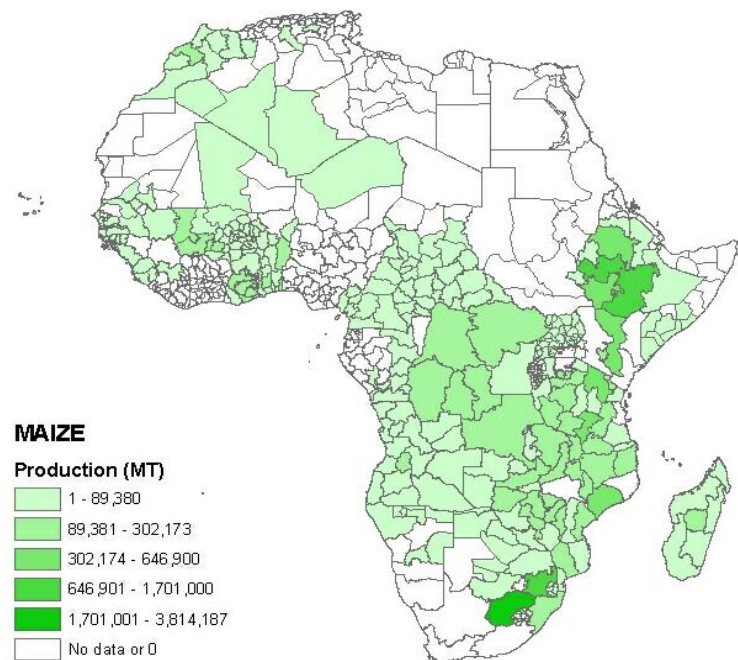
FAOSTAT

Crop distribution - Maize

Agro-MAPS




Statistics aggregated
by **57** Countries

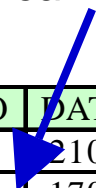


Statistics aggregated by
5690 Administrative units

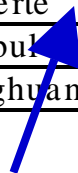
Compilation - tabular statistics

FAO codes

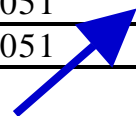
barley 


area harvested 

NAME1	NAME2	CODE	ITEM_CODE	YEAR	ELEMENT_CO	DATA	COMMENTS
Region 1	Ariana	TUN001001	44	1994	031	2100	
Region 1	Ben Arous (Tunis Sud)	TUN001002	44	1994	031	1700	
Region 1	Tunis	TUN001003	44	1994	031	300	
Region 2	Bizerte	TUN002001	44	1994	031	6000	
Region 2	Nabul	TUN002002	44	1994	031	17300	
Region 2	Saghuan	TUN002003	44	1994	031	2800	
Region 1	Ariana	TUN001001	44	1994	051	1900	
Region 1	Ben Arous (Tunis Sud)	TUN001002	44	1994	051	1500	
Region 1	Tunis	TUN001003	44	1994	051	400	
Region 2	Bizerte	TUN002001	44	1994	051	5400	
Region 2	Nabul	TUN002002	44	1994	051	18600	
Region 2	Saghuan	TUN002003	44	1994	051	3400	

Spelling; name changes
redistricting 

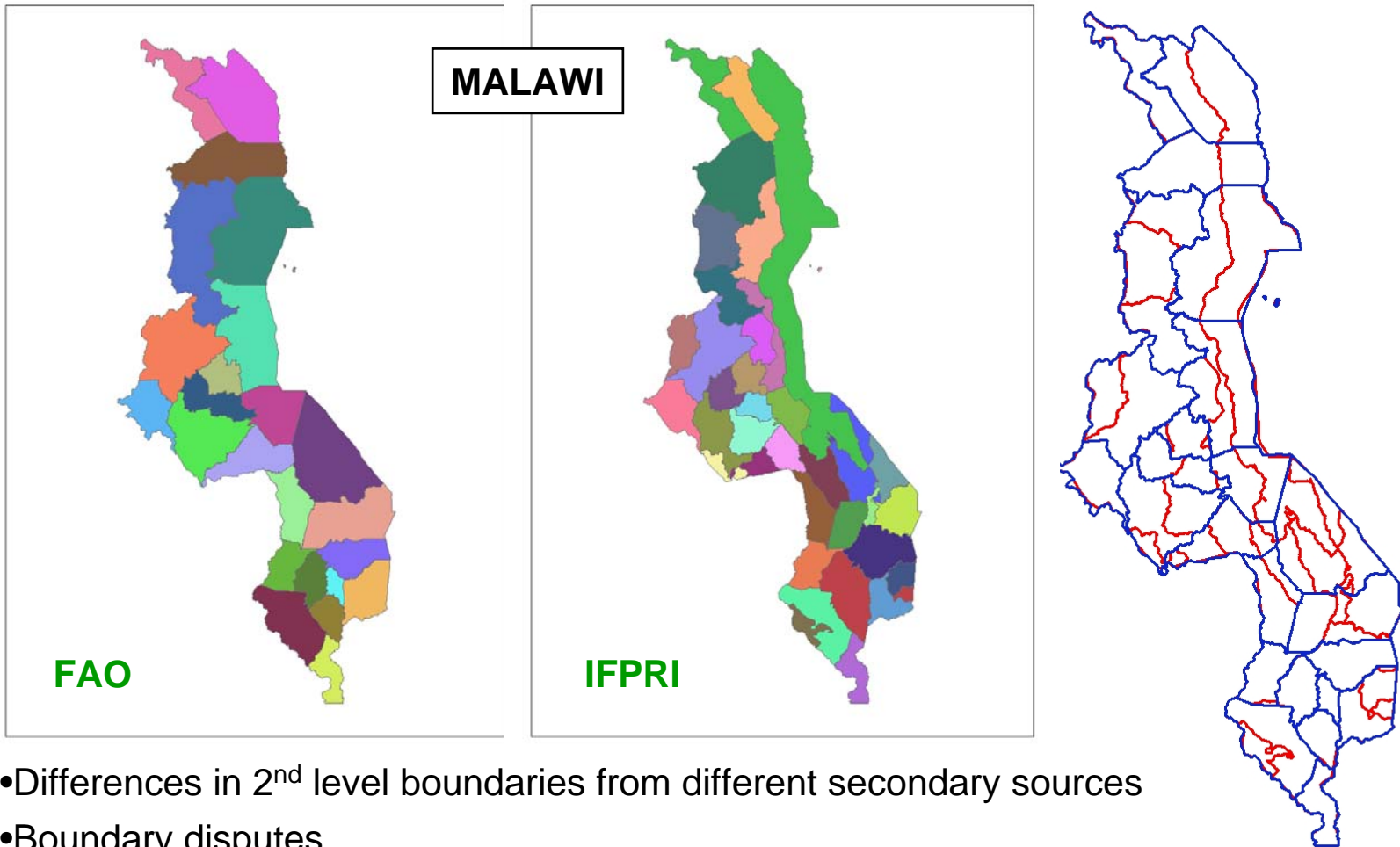
Boundary file codes:
SALB

production 

Missing; not available; zero;
validation vs FAOSTAT 

- Data from diverse sources; IPR issues
- Harmonization; accuracy!!

Compilation of boundaries



- Differences in 2nd level boundaries from different secondary sources
- Boundary disputes
- Coding scheme

GIS technology constraints: maps from different sources may not match



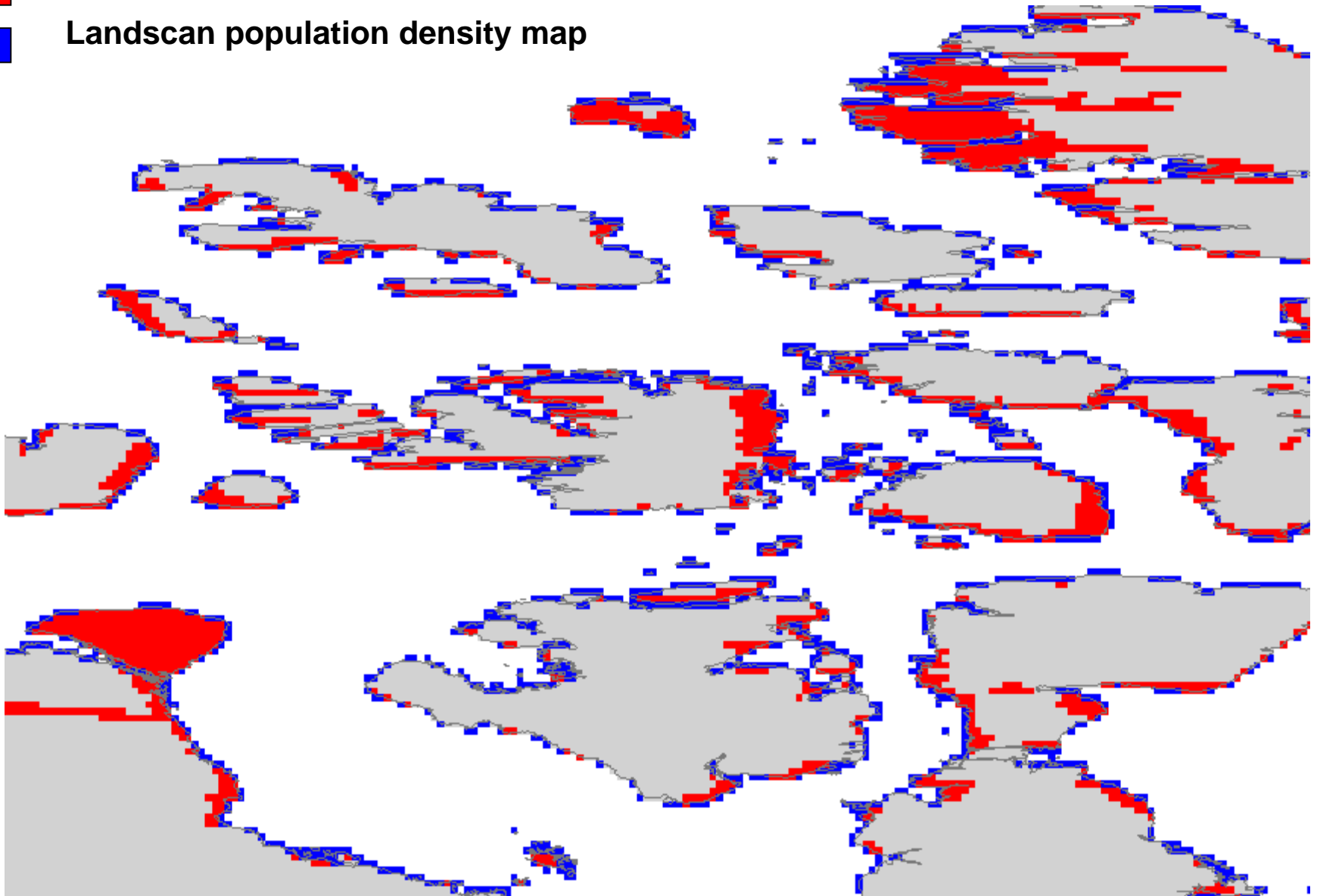
FAO/UNESCO Soil map of the World



UN standard coastlines/country boundaries



Landscan population density map



Observational Needs – and Socio / Econ. Needs -

Have access to data related to the food security indicators listed below:

- Economic and Social data Integration – Macro – micro levels scaling issues- aggregation, disaggregation, data collection issues – sampling , census? Quality control and validation? Terminology highly variable between countries.**
 - World market (availability, prices)**
 - Local market (availability, prices),**
 - Trade, accessibility, productivity indicators, pop data, etc..etc etc. demographics human and animal,**
 - Reliability and availability of time series? Global needs some improved consistency**
 - RS observations are Trans boundary how do we harmonise the same for socio/econ variables e.g. FAO/CESIN new pop product, human influence over time on land management, pop movement – urbanization/ degradation/loss of agric land , huge geographical variations in availability and quality**