

EARTH OBSERVATION AND GEOSPATIAL APPLICATIONS IN THE ENERGY SECTOR

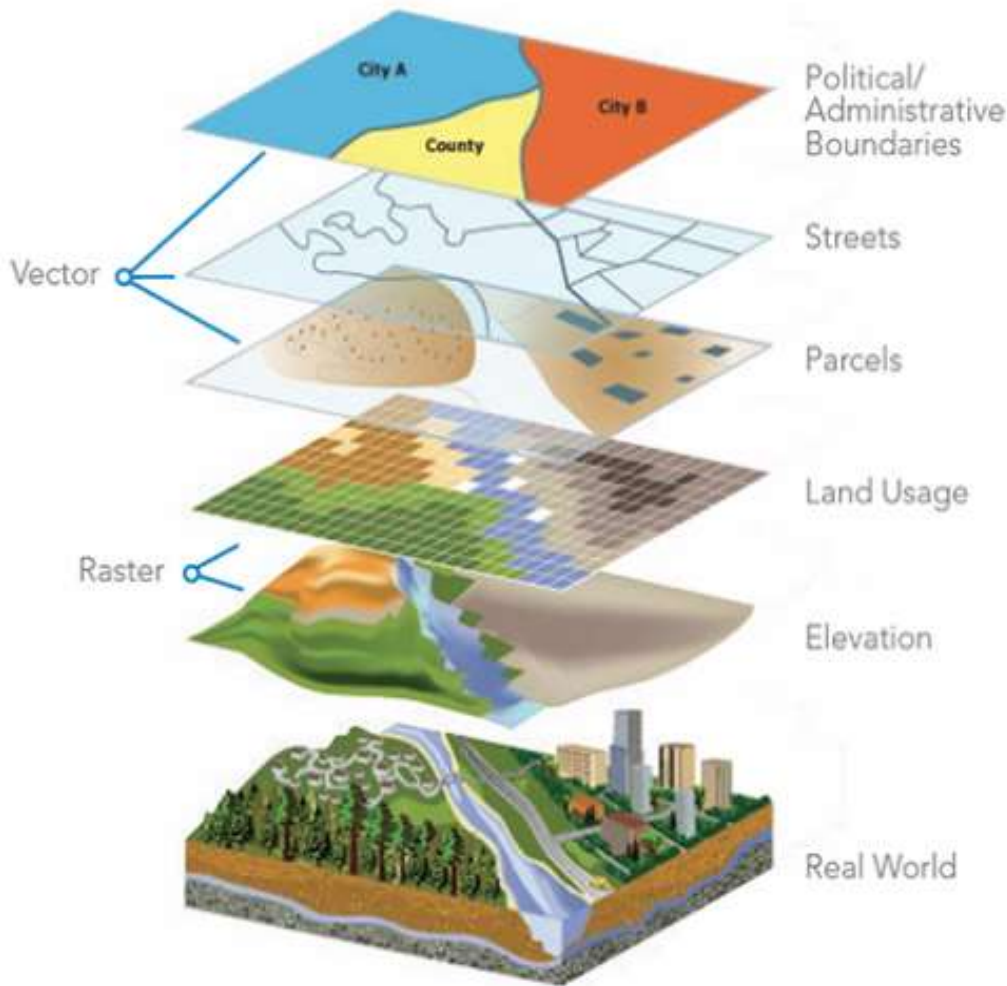
NASA Energy Management Stakeholder Ideation Workshop

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4/27/2016



BETTER SPATIAL DATA AND TOOLS CAN HELP DEVELOPING COUNTRIES TACKLE ENERGY SECTOR CHALLENGES IN ACCESS, RE DEVELOPMENT, ENERGY EFFICIENCY AND DISASTER RISK MANAGEMENT



BETTER DATA TO FACE COMPLEXITY

Growing geospatial data available (remote sensing, high-res photo, automated image processing)

... and collection methods (crowd-sourced information, mobile tools, cloud storage)

Area-wide and up-to-date maps could help in the early phase to identify priority areas and plan sustainable interventions

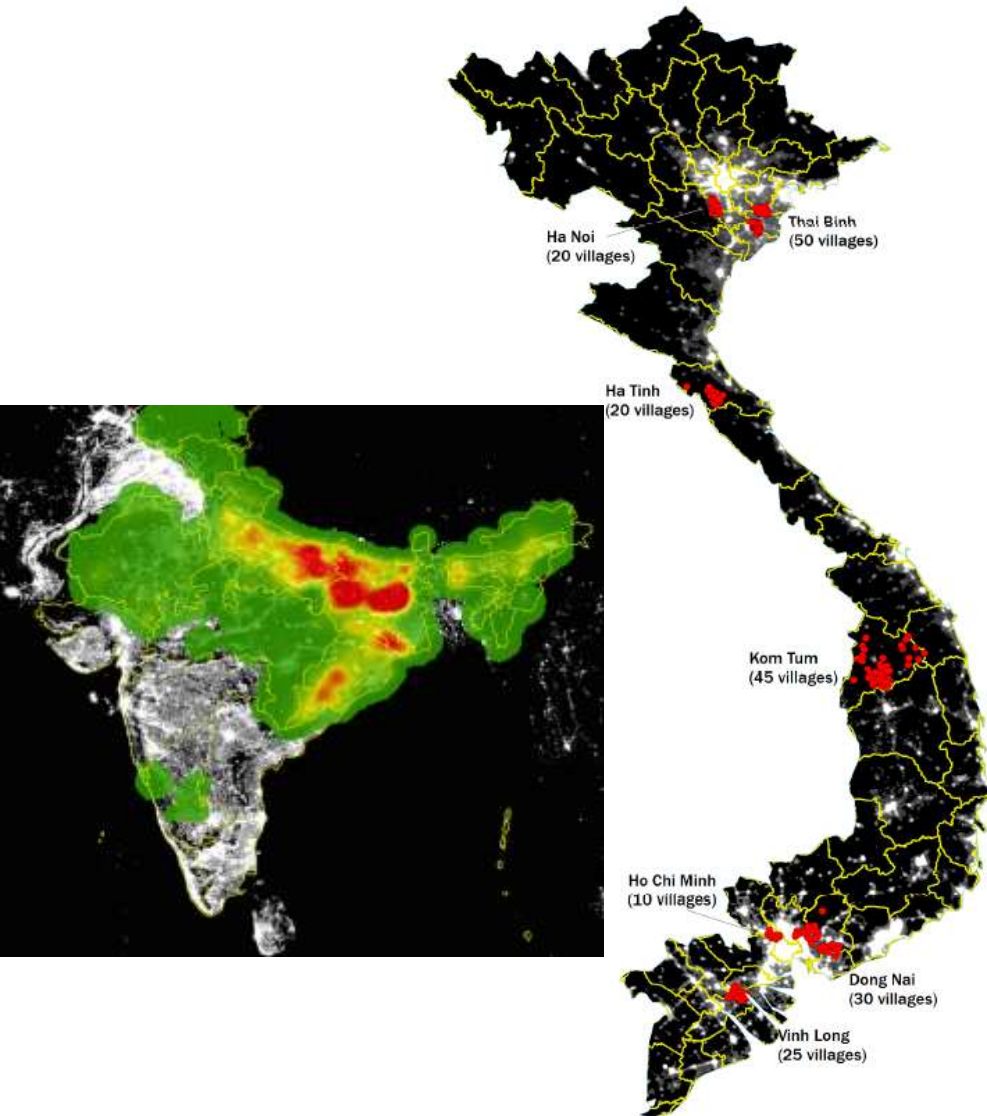
Growing array of innovative solutions (open source software, community mapping) suitable for low capacity settings

Agreed standards observed for collaboration among multiple mapping agencies

ACCESS: EXAMPLE 1

MONITORING RURAL ELECTRIFICATION FROM SPACE

Figure 3. Location of surveyed villages.



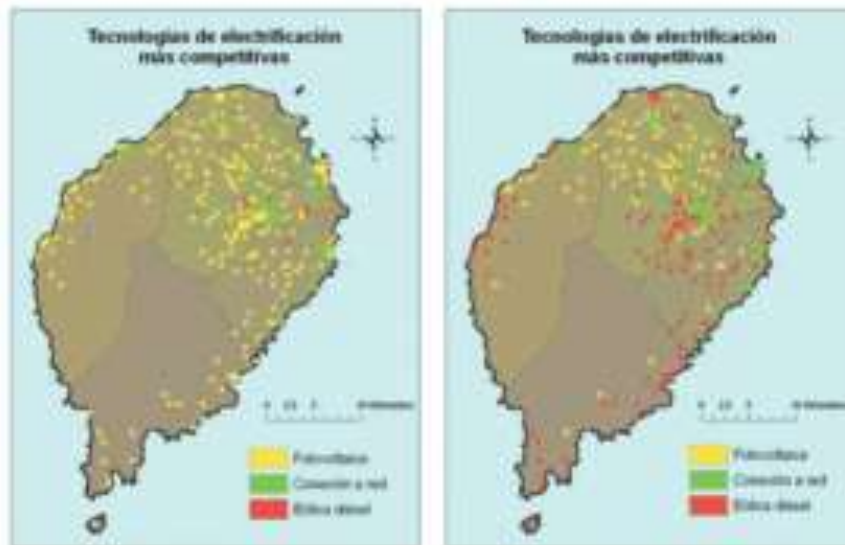
- The Tracking Light From the Sky WB Project works in collaboration with National Oceanic and Atmospheric Administration (NOAA), University of Michigan, and Development Seed.
- Data-intensive strategy to improve the monitoring of electricity service provision to rural areas in India, following the successful demonstration of the effectiveness of night-time lights satellite imagery for rural electrification monitoring in Africa (Mali, Senegal) and East Asia (Vietnam).
- The project collected and analyzed a unique historical archive of nighttime satellite imagery to track the supply of electricity service at the village level spanning nearly 8,000 nights since 1993 in 600,000 villages in India.

ACCESS: EXAMPLE 2

GRID PLANNING AND ISOLATED RURAL COMMUNITIES



- Acciona Microenergía Foundations, committed to the goal of achieving universal access to energy by 2030, has identified the need to supply integrated planning methodologies for rural electrification based on the consideration of several existing technologies, these being grid extension, hybrid and renewable.

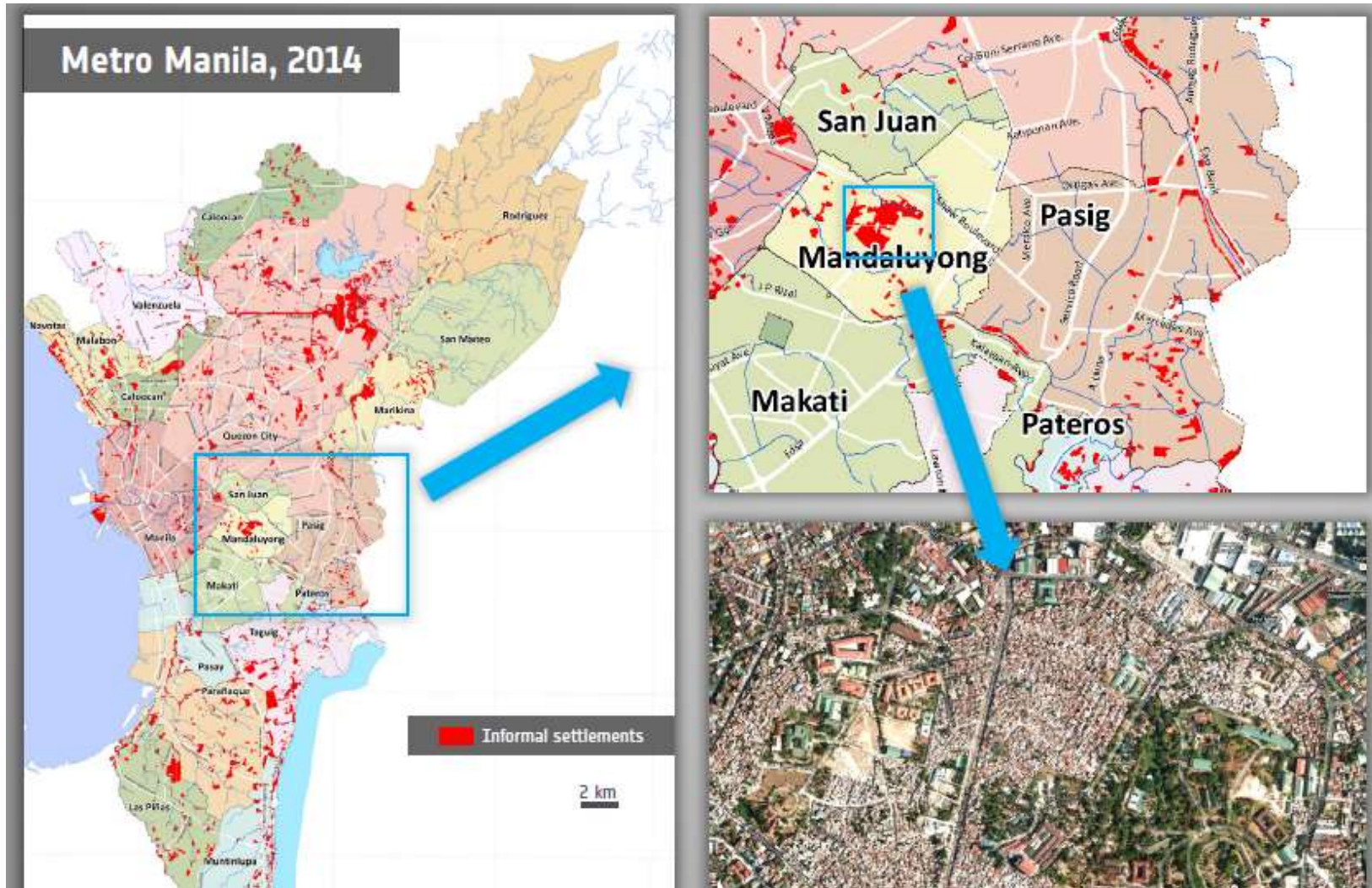


- IntiGIS is a Geographic Information System (GIS) which seeks to serve as a useful decision-making tool on rural electrification and decentralized electricity generation projects with renewable energies.

ACCESS : Example 3-Slum identification for access projects

EXAMPLE 1: WBG-ESA collaboration Metro Manila, 2014 Detection of Informal Settlements

EXAMPLE 2: "Spatial Development of African Cities" (P148736)

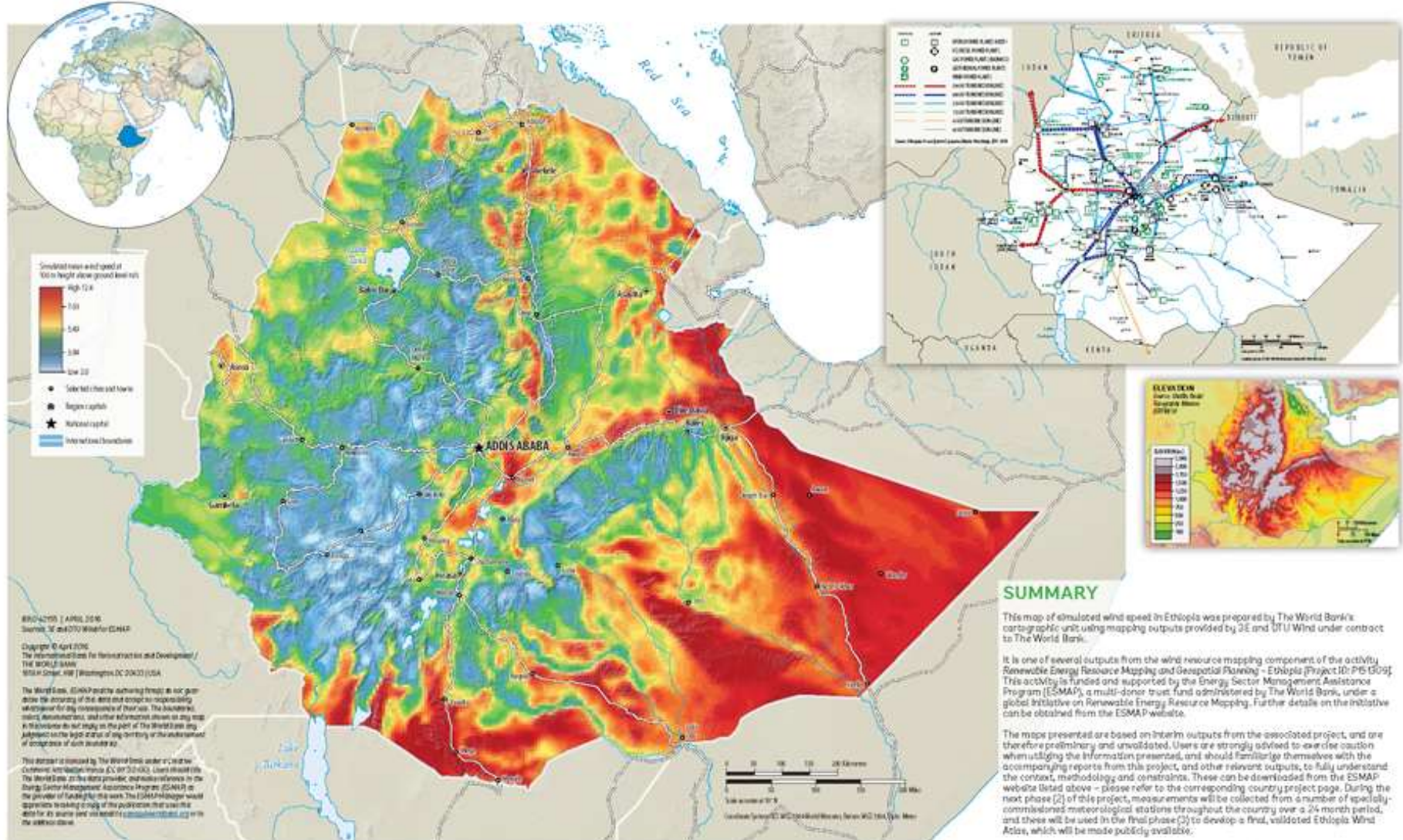


Remote Sensing identifies **INFORMALITY** based on physical and morphological characteristics (size of housing structures, density, size and amount of streets, absence of regular spatial patterns, irregular outline, etc) that allow for discriminating them from other residential areas.

RENEWABLE ENERGY: EXAMPLE 1-RE RESOURCE MAPPING



WIND RESOURCE Ethiopia



ERR042788 | APRIL 2016
Source: GE and DTU Wind for ESMAP
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RENEWABLE ENERGY: EXAMPLE 2- GEOSPATIAL PLANNING FOR VRE

Eastern Africa Power Pool

RENEWABLE ENERGY ZONES

Total Levelized Cost of Electricity (USD/MWh)

Wind	Solar PV	Solar CSP
< 50	< 120	< 200
51 - 60	121 - 125	201 - 205
61 - 70	126 - 130	206 - 210
71 - 80	131 - 135	211 - 215
81 - 90	136 - 140	216 - 220
91 - 100	141 - 145	221 - 225
101 - 110	146 - 150	226 - 230
111 - 120	151 - 155	231 - 235
121 - 130	156 - 160	236 - 240
> 131	> 161	> 241

INFRASTRUCTURE

Major cities (black silhouette) — Roads (grey line)

Power plants

Operational	Potential/proposed
Wind (black silhouette)	Wind (blue circle)
Solar PV (black silhouette)	Solar PV (yellow circle)
Solar CSP (black silhouette)	Solar CSP (red circle)
Geothermal (black silhouette)	Geothermal (green circle)
Biomass (black silhouette)	Biomass (green square)
Hydropower (black silhouette)	Hydropower (blue triangle)
Diesel (black silhouette)	Diesel (blue square)
Natural Gas (black silhouette)	Natural Gas (orange square)
Coal, oil (black silhouette)	Coal, oil (red square)
Nuclear (black silhouette)	Nuclear (purple square)

Transmission lines

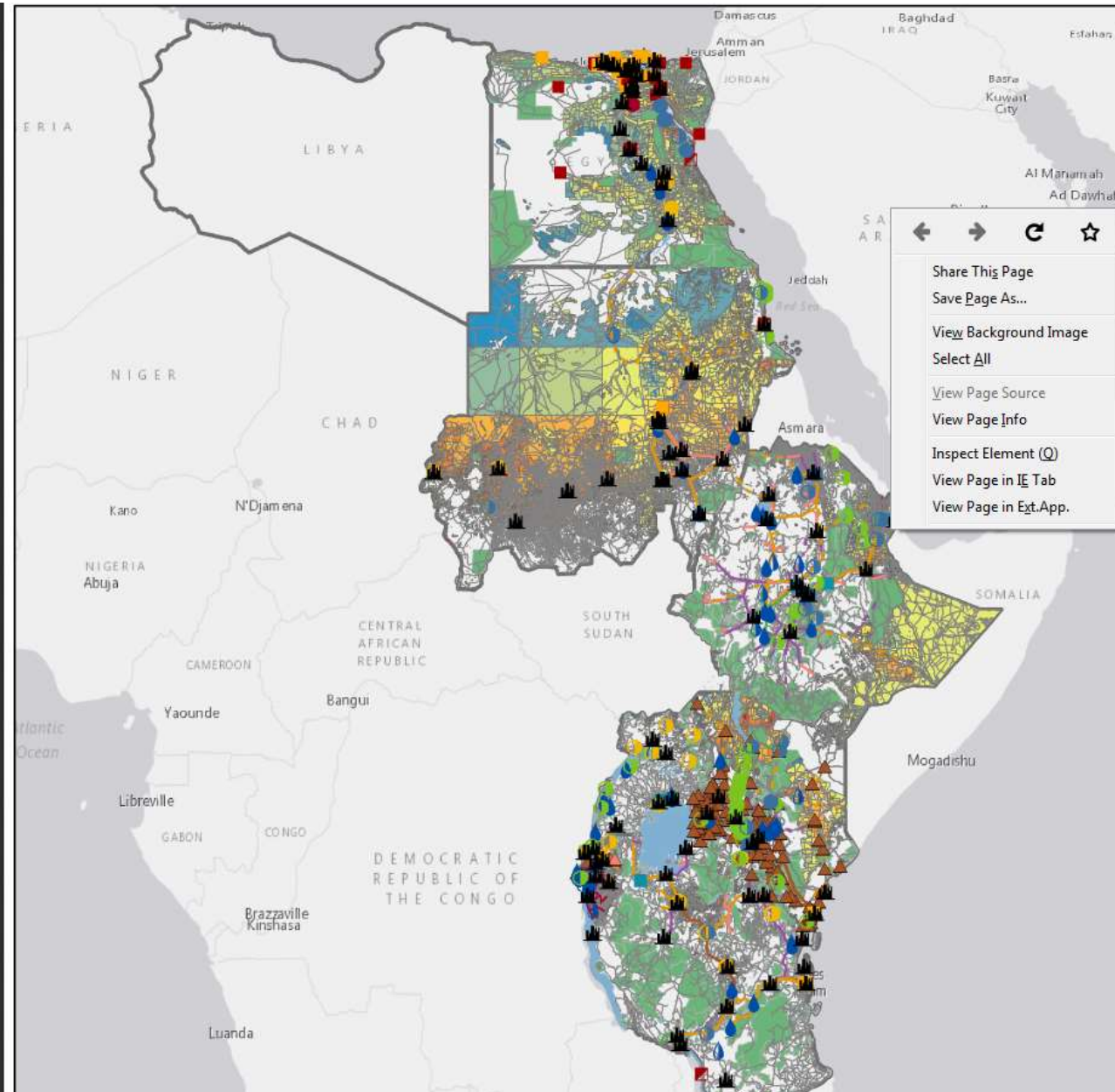
Existing	Planned	Existing	Planned
— > 500 kV	— 101 - 200	— 66 - 100	— Unknown
— 401 - 500 kV			
— 301 - 400 kV			
— 201 - 300 kV			

Substations

Maximum rating (kV)
> 400 (blue triangle)
301 - 400 (green triangle)
201 - 300 (yellow triangle)
101 - 200 (purple triangle)
66 - 100 (red triangle)
Not specified (black triangle)

DEVELOPMENT CONSTRAINTS

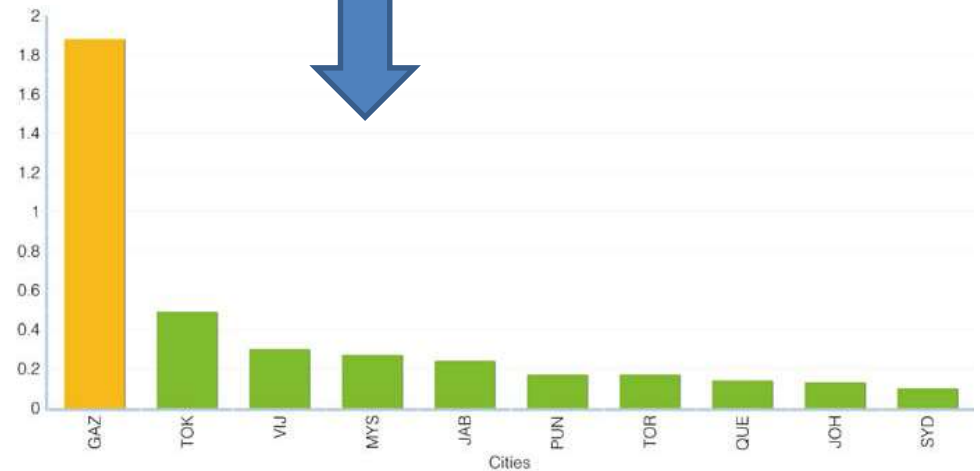
Protected areas (green square) Water bodies (blue square)



ENERGY EFFICIENCY: EXAMPLE: ESTIMATIONS OF CONSUMPTION AND ENERGY DENSITY



Climate data are used in determining heating and cooling days for the building sector, demand forecast and in the estimation of energy consumption densities for electricity, transport and water services.

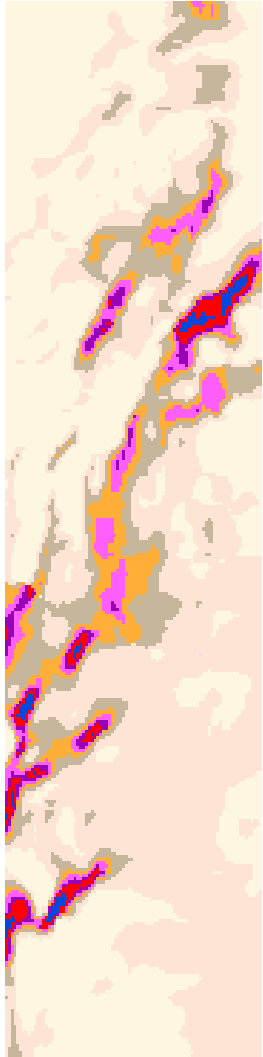


Back-up info

Renewable Energy: Resource Mapping INITIATIVE

- Launched in October 2012; Budget of \$22.5m
- Targets strategic level resource mapping to support government planning and commercial development
- Bank-executed projects supported by ESMAP with funding and technical support
- Covers biomass, small hydro, solar and wind

Country	Biomass	Small Hydro	Solar	Wind
Ethiopia				✓
Indonesia		✓		
Madagascar		✓		
Malawi			✓	
Maldives			✓	✓
Nepal				✓
Pakistan	✓		✓	✓
Papua New Guinea				✓
Tanzania		✓	✓	✓
Vietnam	✓	✓		✓
Zambia			✓	✓



Governments

- Quantifies resource potential**
- Helps identify best areas for development**
- Improved data for setting policy incentives**

Commercial Developers

- Information on high potential areas**
- Reduces project uncertainty and risks**
- Source of validation data for site assessment**

Expert Community

- Contributes to IRENA Global Atlas**
- Supports basic and applied research**
- Methodological and modeling improvements**



Training and capacity building

Geospatial planning and strategic
environmental assessment

Phase 1

Preliminary resource assessment based on modeling of satellite, meteorological, and other public data

Phase 2

Measurement and/or survey data commissioned to improve and validate preliminary modeling outputs

Phase 3

Finalization and publication of validated resource atlas and accompanying datasets

- **Inform development of policy, regulation and guidance by governments**
- **Support site identification and assessment by commercial developers**

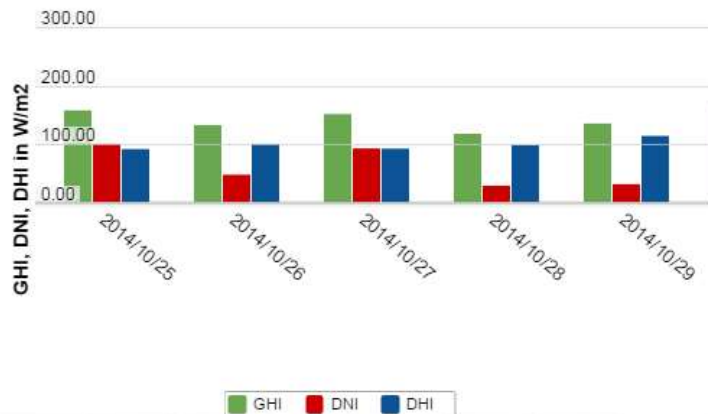
PAKISTAN SOLAR MEASUREMENT DATA



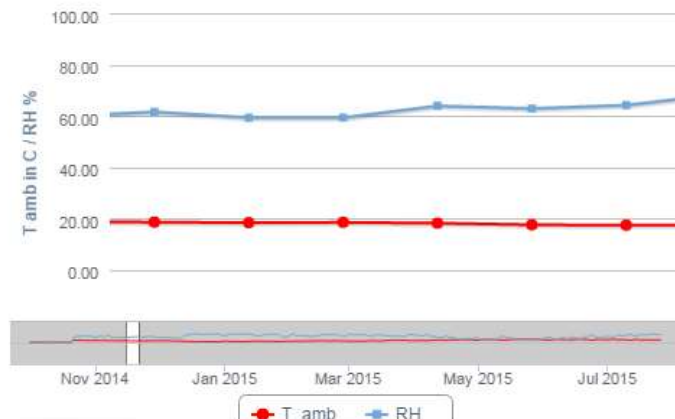
The locations mapped represent sites that are currently delivering measurement data. A click on each location provides a quick link to the measurement data. The map is updated with every new site that starts transmitting data.

Charts:

Multan: Solar Irradiance, daily avg



Lahore: Temp & RH daily avg



RENEWABLE ENERGY: VARIABLE RENEWABLE ENERGY GRID INTEGRATION

