GEOSPATIAL INPUTS TOWARDS
Policy perspective, related initiatives and programs in India
Natural Capital Accounting and Valuation of Ecosystem Services Project

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Group Director, LRUMG, RSAA
National Remote Sensing Centre (NRSC) / ISRO
Department of Space, Hyderabad

Date: 12-Oct-2017 (Thursday)
Venue: DOSD of MoSPI, New Delhi
EARTH OBSERVATION SYSTEMS

- Natural Resources Inventory, analysis and Monitoring
- Towards Meeting Sustainable Development Goals
- Disaster Management Support
- Governance, Planning, Monitoring and Decision Support....etc
NR Census Themes

- LULC-250K
- LULC-50K
- LAND DEGRADATION
- SOIL
- GROUND WATER
- VEGETATION TYPE
- BIODIVERSITY
- WASTELAND
- GEOMORPHOLOGY
- SNOW/GLACIERS
- WETLANDS
- BHOOSAMPADA

IRS Data

- Land Degradation
- Geomorphology
- Wasteland
- Soils
- Ground water
- Wetlands
- Biodiversity
- Forest & Vegetation
- Land Use Land
- Snow Cover /Glacier
GEOSPATIAL TOOLS IN THE ASSESSMENT OF ES

• Ecosystem services are produced by organisms (Ecosystem Service Providers) & their activities (Ecological processes and functions) which are invariably related to the physical environment – Ecosystem

• There are several drivers of change affecting the ecosystems, ecological processes, organisms and hence the ecosystem services

• Mapping of the ESPs, habitats, ecosystem, landscape, watershed based on bio-physical variables

• Monitoring at various spatial and temporal resolutions – tracing the drivers of change
LAND USE LAND COVER INVENTORY USING SATELLITE DATA

Tarapur, Maharashtra
<table>
<thead>
<tr>
<th>Theme</th>
<th>Major Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Resources</td>
<td>Resources assessment, Information products, Hydrologic modeling &amp; services, Customised BHUVAN applications</td>
</tr>
<tr>
<td>Agriculture</td>
<td>Agricultural drought vulnerability, Crop intensification and insurance, Decision Support Systems for crops, Expansion and management of Horticulture crops, Inventory &amp; evaluation of high value crops</td>
</tr>
<tr>
<td>Land Resources Inventory and Monitoring</td>
<td>National Level LULC mapping at 1:250K &amp; 1:50K and Land Degradation mapping at 1:50K, Soil Health Cards, Monitoring and Evaluation of Watersheds using Geospatial Techs, GIS Implementation of Mahatma Gandhi NREGA ASSETS</td>
</tr>
<tr>
<td>Urban Studies &amp; Geo-informatics</td>
<td>AMRUT at 1:4,000 scale geospatial database for 500 cities, Creation of 1:50K scale geospatial database for NCR regional Plan -2021: and change analysis, Housing for all PMAY (Urban) : Monitoring beneficiary house construction through geotagging, Geospatial technology for GAIL pipeline monitoring and surveillance</td>
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<td>ISRO DMS Programme</td>
<td>Natural Disasters - Monitoring/ Damage Assessment, National Database - NDEM, International Charter on Space &amp; Major Disasters, SPIDER, Sentinel Asia, …, Capacity Building on DMS Training Prog</td>
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<tr>
<td>Geosciences</td>
<td>Mineral exploration &amp; Geo-environment, Hydrogeology, Geohazards &amp; Geodynamics</td>
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<tr>
<td>LEVEL</td>
<td>SCALE</td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
</tr>
<tr>
<td>1.National</td>
<td>1:500,000</td>
</tr>
<tr>
<td>2.State</td>
<td>1:250,000</td>
</tr>
<tr>
<td>2.District</td>
<td>1:50,000</td>
</tr>
<tr>
<td>3. Village</td>
<td>1:10,000</td>
</tr>
<tr>
<td>4. Cadastral ??</td>
<td>1:5,000</td>
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</table>
Land use and Land cover Mapping

Annual Basis

1:250,000 mapping using AWiFS data

Digital Classification Approach
Eight Cycles Completed from 2004

Five yearly Basis

1:50,000 mapping using IRS LISS III data

Visual Interpretation
2005-06 as base year

2005-06 / 2011-2012
Change Assessment through Updation of vector layers

1:25,000 mapping using IRS LISS IV data

Visual Interpretation
Of major areas of change

Minimum of 50 sites
Representative of major ecosystems
Land Cover and Land Use Change Research

Multi SENSOR Systems

Automated Semi automated Visual methods

Geospatial & Process MODELS Information Systems

Extensive GROUND Database

USER Driven Systems

National Regional Local D’base

Different Temporal scales

Socio Economic Imperatives

N N R M S

Food Security Water Security Habitat Conservation

Ecological Imperatives

IGBP

Carbon & Hydrology Biodiversity Change Atmospheric Studies
LULC Databases & Application

- **SPOT WIFS**
  - National Database
  - Phenological Natural formations
  - Biome level Classification
  - Broad land use 1:1 M
  - 1998/2000

- **IRS AWIFS**
  - National Database
  - Phenological Natural formations
  - Cropping Patterns
  - Surface water, Land use 1:250K
  - 2004,'05,'06,'07 Annual Product

- **IRS LISS III**
  - National Database
  - NR Census (6themes)
  - Phenological & Composition formations
  - Detailed Land-use database
  - 1:50 k
  - MARCH 09 Five year product

- **IRS L IV / CARTO**
  - Database for Hotspots, NUIS
  - Composition/species level
  - Topography
  - Micro level L Use
  - >1:25 k

- **IRS LISS III**
  - National Database
  - NR Census (6themes)
  - Phenological & Composition formations
  - Detailed Land-use database
  - 1:50 k
  - MARCH 09 Five year product

- **LULC Planning and monitoring**
  - Carbon & Trace Gas Inventory
  - Biodiversity Change, Disasters
  - River Basin Land cover Dynamics

- **Integrated LU Mgt.**
  - Biodiversity Change
  - Affor/Reforestation

- **Urban Planning, CDMs**
  - Affor/Reforestation
  - Biodiv. Conservation

- **Case/Need Based Specific**
All interim Kharif and integrated LULC assessments were completed as per the schedule and reports were submitted by 31st December of each year.
End of season of assessment of Kharif, rabi and integrated LULC at the end of yr 13ycles completed. Temporal analysis carried out to find consistently cropped and fallow areas.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>NET SOWN AREA (Mha)</th>
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<tbody>
<tr>
<td>2004-05</td>
<td>140.8</td>
</tr>
<tr>
<td>2005-06</td>
<td>144.0</td>
</tr>
<tr>
<td>2006-07</td>
<td>143.7</td>
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<tr>
<td>2007-08</td>
<td>139.7</td>
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<tr>
<td>2008-09</td>
<td>145.0</td>
</tr>
<tr>
<td>2009-10</td>
<td>143.9</td>
</tr>
<tr>
<td>2010-11</td>
<td>149.3</td>
</tr>
<tr>
<td>2011-12</td>
<td>149.0</td>
</tr>
<tr>
<td>2012-13</td>
<td>148.2</td>
</tr>
<tr>
<td>2013-14</td>
<td>148.5</td>
</tr>
</tbody>
</table>

Study area: India
Sensor: Resourcesat-1 / 2 AWiFS.
Study duration: 2004-05 to 2018-19 (15 cycles)

No. of requests Served: 275
No. Of Unique Organizations / Users registered for data: 132 / 257
Volume of the Data provided: ~16.25 GB
<table>
<thead>
<tr>
<th>S. No</th>
<th>Class name</th>
<th>2014-15</th>
<th>2015-16</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Built-up</td>
<td>9.74</td>
<td>9.74</td>
</tr>
<tr>
<td>2</td>
<td>Kharif crop</td>
<td>45.29</td>
<td>57.02</td>
</tr>
<tr>
<td>3</td>
<td>Rabi crop</td>
<td>18.59</td>
<td>15.03</td>
</tr>
<tr>
<td>4</td>
<td>Zaid crop</td>
<td>1.54</td>
<td>0.28</td>
</tr>
<tr>
<td>5</td>
<td>Double/triple crop</td>
<td>67.68</td>
<td>65.31</td>
</tr>
<tr>
<td>6</td>
<td>Current fallow</td>
<td>30.79</td>
<td>28.58</td>
</tr>
<tr>
<td>7</td>
<td>Plantation</td>
<td>9.46</td>
<td>9.46</td>
</tr>
<tr>
<td>8</td>
<td>Evergreen forest</td>
<td>17.29</td>
<td>17.28</td>
</tr>
<tr>
<td>9</td>
<td>Deciduous forest</td>
<td>46.94</td>
<td>46.91</td>
</tr>
<tr>
<td>10</td>
<td>Degraded/scrub forest</td>
<td>10.80</td>
<td>10.98</td>
</tr>
<tr>
<td>11</td>
<td>Littoral swamp</td>
<td>0.44</td>
<td>0.44</td>
</tr>
<tr>
<td>12</td>
<td>Grassland</td>
<td>2.39</td>
<td>2.37</td>
</tr>
<tr>
<td>13</td>
<td>Shifting cultivation</td>
<td>0.22</td>
<td>0.07</td>
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<tr>
<td>14</td>
<td>Wasteland</td>
<td>47.26</td>
<td>44.72</td>
</tr>
<tr>
<td>15</td>
<td>Rann</td>
<td>1.63</td>
<td>1.63</td>
</tr>
<tr>
<td>16</td>
<td>Waterbodies max</td>
<td>9.76</td>
<td>9.77</td>
</tr>
<tr>
<td>17</td>
<td>Waterbodies min</td>
<td>3.01</td>
<td>2.39</td>
</tr>
<tr>
<td>18</td>
<td>Snow cover</td>
<td>4.30</td>
<td>5.14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Net Sown Area</th>
<th>Total Forest cover</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>133.10</td>
<td>75.47</td>
</tr>
<tr>
<td></td>
<td>137.64</td>
<td>75.61</td>
</tr>
</tbody>
</table>
Indian National Communication to UNFCCC

Remote Sensing based Inputs to Land use, land-use Change and Forestry (LULUCF)

LU/LC – 2009-’10 Integrated with FSI-FC
LU/LC – 2012-13 Integrated with FSI-FC
<table>
<thead>
<tr>
<th>Level 1 Class</th>
<th>TOTAL (sq.km)</th>
<th>2005-06</th>
<th>2011-12</th>
<th>Change</th>
<th>% TGA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Built Up</td>
<td></td>
<td>100039.84</td>
<td>106240.88</td>
<td>6201.04</td>
<td>0.19</td>
</tr>
<tr>
<td>Agricultural Land</td>
<td></td>
<td>1798669.03</td>
<td>1801940.70</td>
<td>3271.66</td>
<td>0.10</td>
</tr>
<tr>
<td>Forest</td>
<td></td>
<td>738516.02</td>
<td>741125.71</td>
<td>2609.69</td>
<td>0.08</td>
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<tr>
<td>Grazing land</td>
<td></td>
<td>35329.84</td>
<td>34907.03</td>
<td>-422.81</td>
<td>-0.01</td>
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<tr>
<td>Wastelands</td>
<td></td>
<td>370538.33</td>
<td>376306.71</td>
<td>5768.37</td>
<td>0.18</td>
</tr>
<tr>
<td>Wetlands</td>
<td></td>
<td>23700.54</td>
<td>23018.05</td>
<td>-682.50</td>
<td>-0.02</td>
</tr>
<tr>
<td>Water bodies</td>
<td></td>
<td>107501.94</td>
<td>110900.18</td>
<td>3398.23</td>
<td>0.10</td>
</tr>
<tr>
<td>Snow &amp; others</td>
<td></td>
<td>112967.21</td>
<td>92823.50</td>
<td>-20143.71</td>
<td>-0.61</td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td>3287263</td>
<td>3287263</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Land Degradation Assessment using multi temporal satellite data

Utility
- Identification of degraded lands for improving productivity
- Reclamation of degraded lands
- Monitoring of degraded lands
- Prioritization of watersheds for treatment
- Environmental studies
National Wastelands Mapping

- Wasteland mapping 1982-1984 1:1M
- Wasteland Change Analysis 2014-2015 - to be initiated

Methodology
- First 3 cycles created using visual methods using single season (rabi) data
- 3rd and 4th cycles adopting on-screen method and using 3 season data. Change analysis carried out.
- 5th cycle will be done using web based approach

Users: Ministries – MRD, Power, Agriculture, MoUD etc., for greening, agriculture, plantation, watershed development; industrial & infrastructure development etc.
Surface Water bodies dynamics for the entire country derived from multi-sensor satellite data and hosted on a Web enabled Water Bodies Information System (WBIS)

- Surface water bodies information is useful for State & Central Irrigation Departments for:
  1) Pre & Post Monsoon scenario
  2) Sustainability Analysis: Inland fisheries
  3) Hydrological Drought Assessment
  4) Surface Storage Quantification

- Satellite data is processed in Automatic Chain in Near Real Time
- Surface Water bodies dynamics is provided through Water Bodies Information System (WBIS) and Bhuvan
- Visualisation & Analytics provided for at Individual water body & Region level
- Water Bodies are monitored:
  - Once in 5 Days (for size > 50Ha)
  - Once in a Month (for size > 2 Ha)
  - Once in a Season (for size > 0.25Ha)
### Operational Web-based National Hydrological Modeling System

#### Hydrological Modeling Framework

- **Variable Infiltration Capacity Hydrological Model**
  - Open source; Grid-wise water and energy balance
  - Sub-grid heterogeneity of Land cover
  - Soil depth-wise hydrological response
  - Vegetation phenological changes
  - Daily / sub-daily time step

- **Input dataset**
  - Variable Infiltration Capacity Hydrological Model
  - Open source; Grid-wise water and energy balance
  - Sub-grid heterogeneity of Land cover
  - Soil depth-wise hydrological response
  - Vegetation phenological changes
  - Daily / sub-daily time step

- **Geo-spatial data**
  - Terrain - Topographic, Soil (NBSSLUP), LULC (NRC-250k), LAI, Albedo
  - Meteorological - Rainfall, Temperature, ... (IMD & CPC)
  - Hydrological - River discharge, Reservoir Storage/Releases, GW levels, ...

- **Output Products**
  - Daily Web Products (9 min (~16.5km), 3 min (~ 5.5km)
    - Surface Runoff
    - Soil Moisture
    - Evapotranspiration

- **9 min (~16.5km), 3 min (~ 5.5km) Grid-wise data base**

- **Soil Moisture**
  - Runoff
  - Soil Moisture
  - Evapotranspiration
Actionable Alerts on Annual Forest Loss Locations – Results for 2015

Total Locations
✓ 2013-14 = 2944
✓ 2014-15 = 2571

Forest Loss Locations (Statewise)

- WEST BENGAL: 79, 433
- UTTAR PRADESH: 22, 108
- UTTARANCHAL: 37, 435
- TELANGANA: 71, 201
- TRIPURA: 14, 173
- TAMILNADU: 14, 214
- RAJASTHAN: 0, 331
- PUNJAB: 80, 214
- ORISSA: 43, 104
- NAGALAND: 6, 57
- MIZORAM: 43, 233
- MADHYA PRADESH: 80, 104
- MANIPUR: 43, 209
- MEGHALAYA: 6, 95
- MAHARASHTRA: 38, 147
- KERALA: 29, 147
- KARNATAKA: 38, 147
- JAMMU & KASHMIR: 2, 96
- JHARKHAND: 1, 232
- HARYANA: 16, 43
- HIMACHAL PRADESH: 16, 232
- GUJARAT: 10, 252
- GOA: 80, 252
- CHHATTISGARH: 20, 157
- BIHAR: 2, 138
- ASSAM: 2, 114
- ANDHRA PRADESH: 77, 118
- ARUNACHAL PRADESH: 134, 235

Location of loss reported (centroid of polygon); Area of loss is not reported
Monitoring and Evaluation of IWMP Watersheds using Geospatial Technologies

Study Area
- IWMP watersheds in Entire India

Total Micro-watersheds covered: ~75000

Srishti: Web GIS using IRS High Resolution image base for monitoring and evaluation

Drishti: Android Application for Real-time Field inventory and uploading to server using Geo-tagged Photo

User: Dept of Land Resources, Min of Rural Development

Budget: IWMP – Rs 35.03 Cr Duration: 2015-16 to 2020

950 OFFICIALS OF DIFFERENT STATES TRAINED IN 17 WORKSHOPS
IWMP II Project Theni Dist., Tamilnadu

2009 Satellite Image

Fallow Land

Feb, 2014 Satellite Image
Monitoring of Farm Ponds in Watersheds

2011

2013
BHUVAN – Indian Geo-Platform of ISRO

- Visualization (23 TB) and Free Download (110 GB)
- Maps & OGC Services (~7000+)
- Applications (200+)
- State Portals (30)
- Crowd Sourcing (14 M)

- More than 1 lakh Registered users
- 36K unique visitors/day
- 6.38 lakhs free download

2009 Visualisation
2012 Mashups
2015 onwards G-Governance Applications
THANK YOU
LAND DEGRADATION MAP

Uttar Pradesh

<table>
<thead>
<tr>
<th>ID</th>
<th>Process</th>
<th>Type - Severity</th>
<th>Symbol</th>
<th>Area (ha)</th>
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<tbody>
<tr>
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<td>Sheet erosion - Slight</td>
<td>(1)</td>
<td>🌿</td>
<td>223922</td>
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<tr>
<td>2</td>
<td>Sheet erosion - Moderate</td>
<td>(2)</td>
<td>🌿</td>
<td>540265</td>
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<tr>
<td>3</td>
<td>Sheet erosion - Severe</td>
<td>(3)</td>
<td>🌿</td>
<td>127998</td>
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<td>4</td>
<td>Rills (4)</td>
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<td>🌿</td>
<td>66630</td>
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<td>5</td>
<td>Gullies (5)</td>
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<td>🌿</td>
<td>420453</td>
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<td>Ravines - Shallow (6)</td>
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<td>Ravines - Moderately deep to deep (7)</td>
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<td>Partially stabilized dunes (5)</td>
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<td>Un-stabilized dunes (6)</td>
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<td>Permanent (2)</td>
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<td>Subsurface waterlogged (3)</td>
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<td>16</td>
<td>Saline - Slight (1)</td>
<td>Moderate (2)</td>
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<td>21</td>
<td>Glacial (8)</td>
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<td>23</td>
<td>Frost Shattering (2)</td>
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<td>NIL</td>
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<td>Industrial effluent affected areas (1)</td>
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<td>Mining and dump areas (2)</td>
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<tr>
<td>27</td>
<td>Mass movement / mass wastage (1)</td>
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<td>🌿</td>
<td>NIL</td>
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<td>28</td>
<td>Barren rocky / Stony waste (2)</td>
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<td>🌿</td>
<td>50239</td>
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<td>29</td>
<td>Miscellaneous-Rivette/Sands/Sea Ingress etc (3)</td>
<td></td>
<td>🌿</td>
<td>24566</td>
</tr>
</tbody>
</table>

Note: Symbol and area statistics are for dominant land degradation type-severity. All degraded classes are shown in Colour

Location Map

Data Source: Dataset (IRS LISS-III) data of 2005/06 with updated field checks and chemical analysis

© National Natural Resources Management System, ISRO, 2012
Wastelands (Conversion & Utilisation)

Wasteland to solar power generation, Charanka solar park Radhanpur, one among 44 such projects in Gujarat State

Path/ Row : 91/55
23° 54' 35" N
71° 12' 04" E

IRS LISS III (05-06)
IRS LISS III (11-12)
IRS LISS III (15-16)
GIS Implementation of Mahatma Gandhi NREGA Assets

**Registration**
- State GIS Nodal Officer
- District GIS Nodal Officer
- GIS Asset Supervisor (Block)

**Web Portal**
- MGNREGA Spatial Enumerator
- MGNREGA Spatial Enumerator
- MGNREGA Spatial Enumerator

**Mobile App**
- Step 1: Click on “Change Gram Panchayat”
- Step 2
Solution Implemented for Governance

Visualisation across geography

Reports at different level of administration are prepared for monitoring geotagging activity.

Statewise Geotags & Panchayat level

Geotagged

Moderate

18.AUG.17

Geotags for Maharashtra

Geotags for Ballarpur Block

Geotags collected in field are validated and accepted as correct by block level officer using Bhuvan interface.

18.AUG.17

2.09 Cr
d

2.04 Cr
d

1.81 Cr
d

0.24 Cr
d
National Rural Drinking Water Programme
(Rajiv Gandhi National Drinking Water Mission)

- Groundwater prospect in 1:50,000 scale map full India Completed
- Groundwater quality mapping is under progress, out of 29 states 5 states completed, other are in advance stage

Resourcesat 1 LISS III, NCC Image

Groundwater prospect map
Pochampally Watershed, Nalgonda Dist. Telangana

POCHAMPALLY WATERSHED, NALGONDA DIST. TELANGANA

GROUNDWATER PROSPECTS INFORMATION

<table>
<thead>
<tr>
<th>FIELD NAME OF WELLS</th>
<th>COLOUR CODE</th>
<th>DEPTH RANGE OF WELLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>N. C.</td>
<td>VIOLET</td>
<td>&gt; 100 LPM</td>
</tr>
<tr>
<td>B. S.</td>
<td>INDIGO</td>
<td>100 - 200 LPM</td>
</tr>
<tr>
<td>M. I.</td>
<td>BLUE</td>
<td>50 - 100 LPM</td>
</tr>
<tr>
<td>P. I.</td>
<td>GREEN</td>
<td>20 - 50 LPM</td>
</tr>
<tr>
<td>B. A.</td>
<td>YELLOW</td>
<td>10 - 20 LPM</td>
</tr>
<tr>
<td>B. Q.</td>
<td>ORANGE</td>
<td>&lt; 10 LPM</td>
</tr>
<tr>
<td>N. P.</td>
<td>RED</td>
<td></td>
</tr>
</tbody>
</table>

Kilometers

Kilometers