An Overview of Application of Geoinformatics in Ecological Studies

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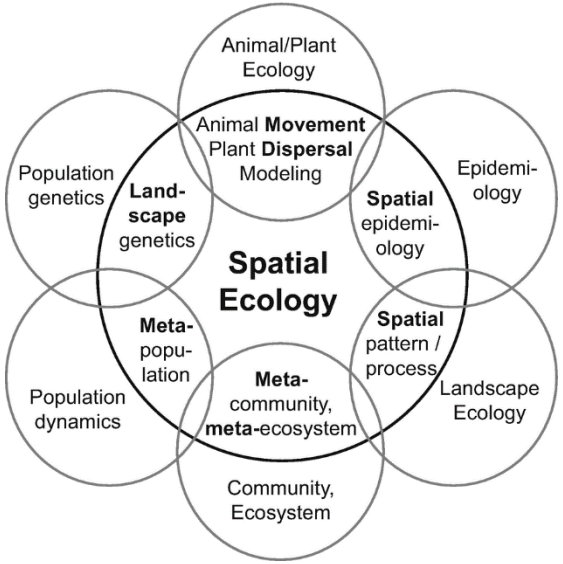
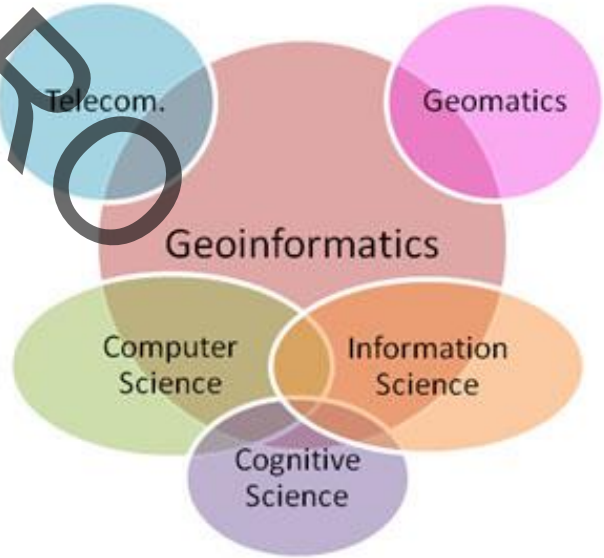
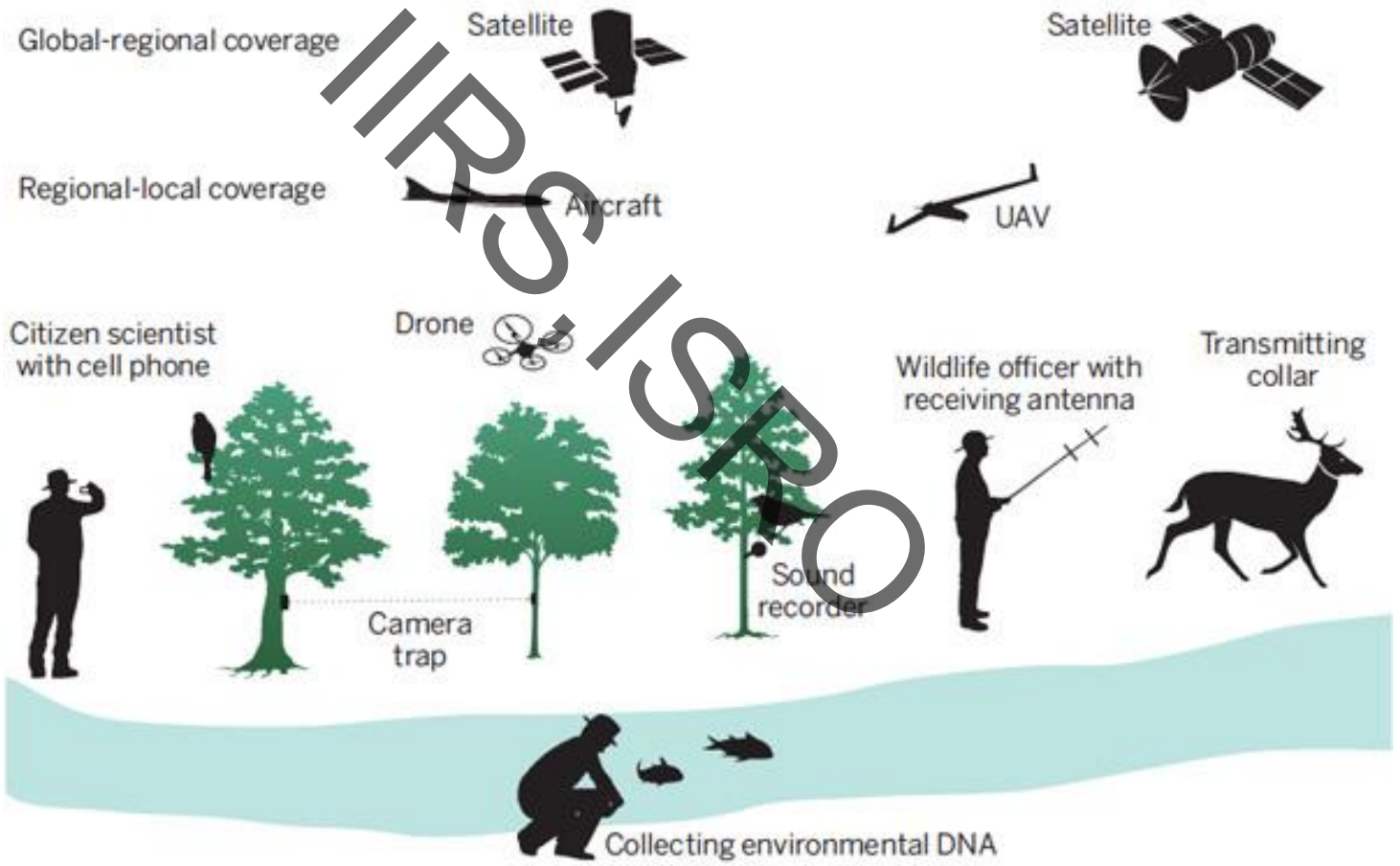
Ecology to Spatial Ecology…

- Spatial ecology focuses on the role of space and time in ecological processes and events from a local to a global scale.
- Particularly relevant in developing policy and monitoring goals.
- Geoinformatics tools addresses emerging issues in spatial ecology.





Geoinformatics tools



Woody Turner 2014

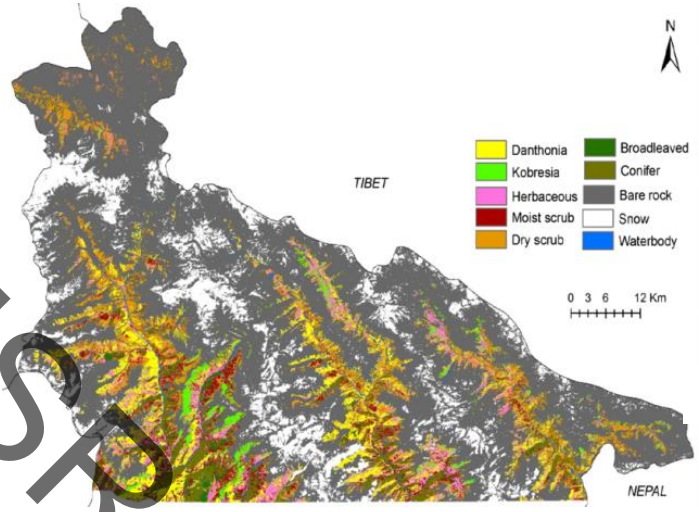
Predicting species distribution

- Ecological niche based prediction of likely areas of occurrence of any species;
- Require presence/absence data with environmental covariates;
- Species response curve highlights species behaviour;
- Models (e.g. MaxEnt) can predict present and future distribution.

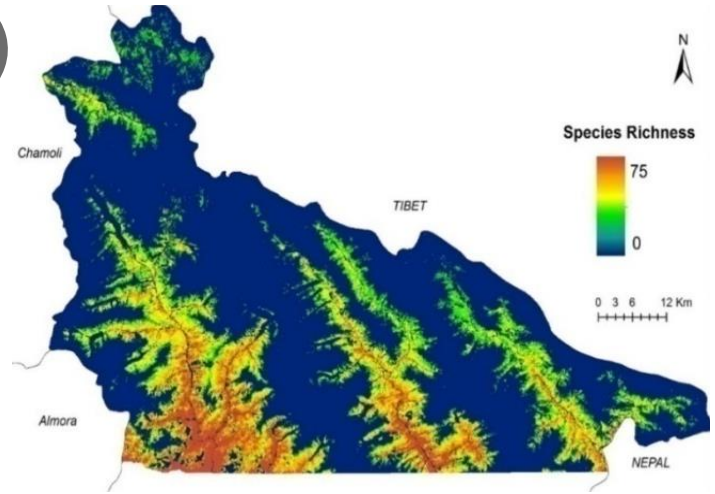
Bushmint invasion in Himalayan foothills

Predicting diversity (alpha, beta) patterns

- Predicting biodiversity is a multi-scale problem.
- Systematic field surveys generate count data (e.g. number of tree species per ha)
- A range of climatic, topographic, landscape variables are available from satellite images to characterize environment;
- Advanced statistical methods (e.g. GLM, Boosted regression trees or machine learning methods (e.g. Random forest) can help in predicting richness patterns.
- R studio offers a range of such technique including methods for validation.

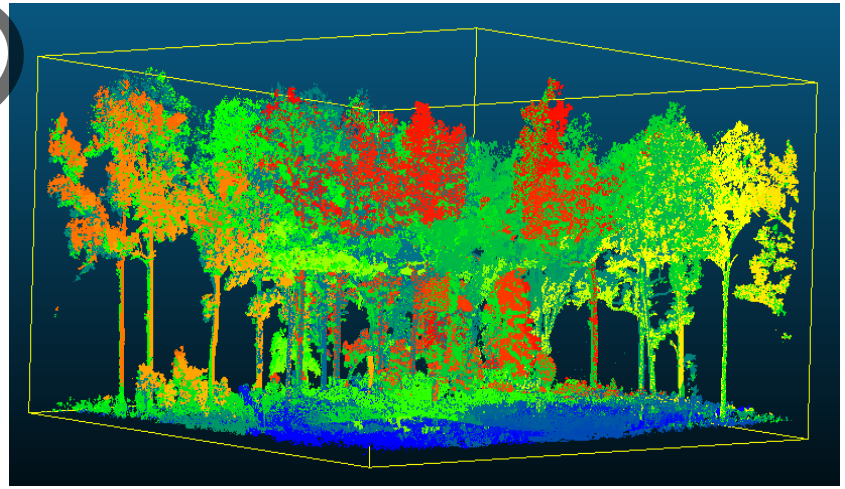


Inventory of plants in 1m X 1 m quadra



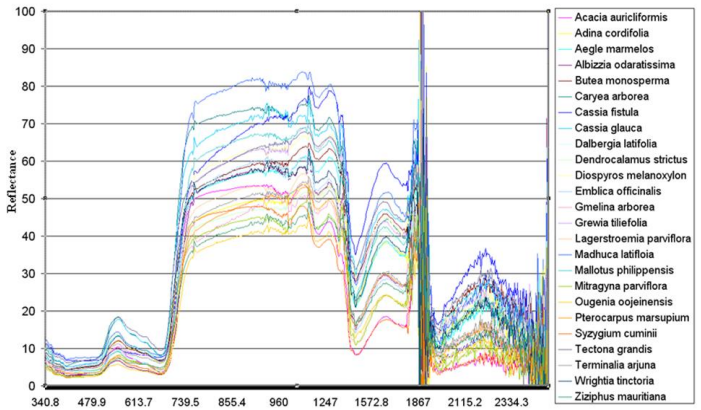
Measuring vertical structure

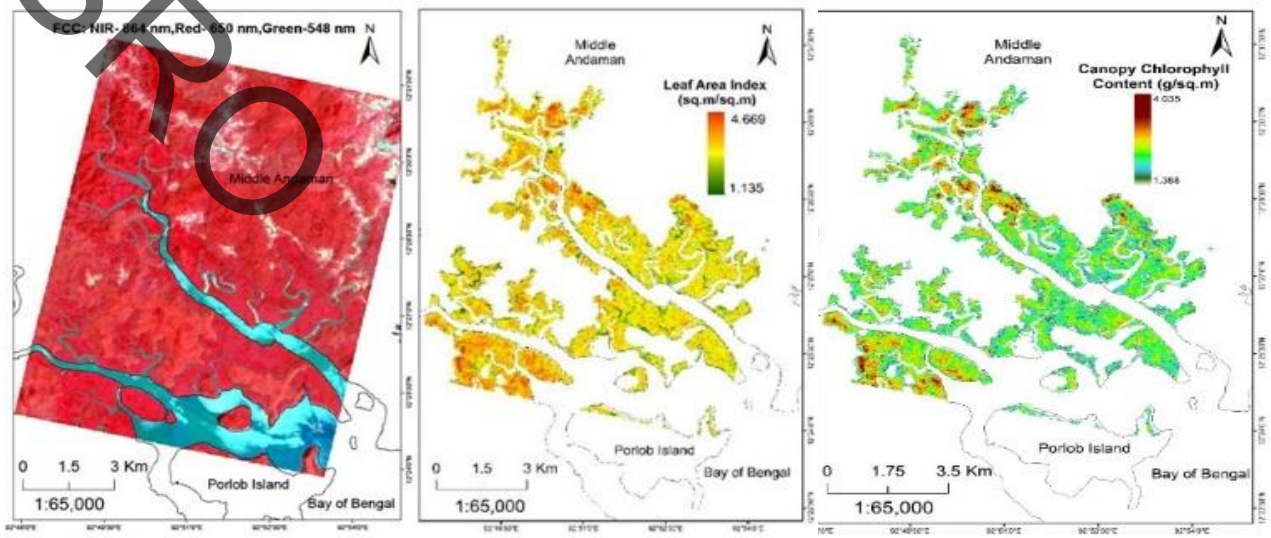
- LiDAR is an active remote sensing technique;
- 3-D information is critical for several ecological studies (e.g. forest biomass, niche partitioning in birds etc.);
- Terrestrial Laser Scanner can offer highly detailed information (e.g. can even locate deformities on the tree trunk);
- Space borne LiDAR Observations from ICESAT-2 and GEDI (on board ISS) are offering global LiDAR footprints;
- In contrary to discrete return (most common) recent availability of waveform LiDAR offer canopy cover, foliage diversity and many other stand and canopy characteristics.



Quantifying foliar traits

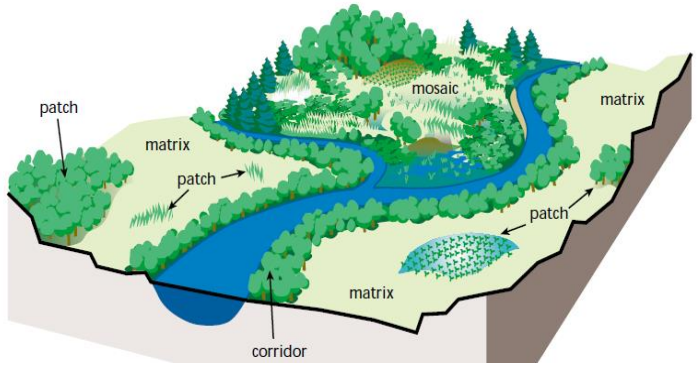
- Foliar traits (e.g. LAI, Chl, Nitrogen, Lignin, cellulose, water content etc.)
- Some of these traits have characteristics absorption features while others are either in very narrow spectral regions or are suppressed by dominant ones.
- Narrow bands of hyperspectral remote sensing can help us in detecting and quantifying the presence and amount of such traits;
- A range of methods from statistical to machine learning to RTM are being used to relate in-situ measured traits with image and predict their values over the landscape.

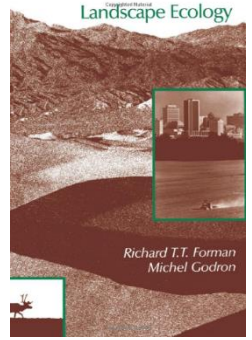


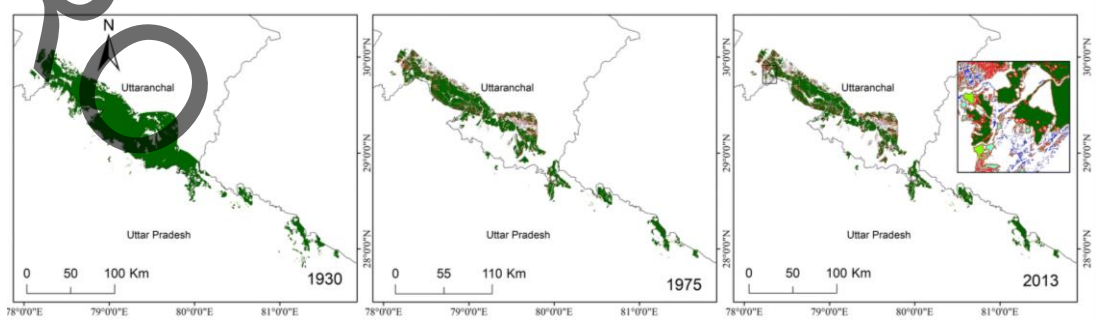


Analysing landscape patterns

- A landscape or seascape is a mosaic of connected ecosystems. Term coined by Carl Troll in 1939.
- Landscape ecology deals with:
  - Structure = the spatial relationships among the distinctive ecosystems or "elements"
  - Function = the interactions among the spatial elements
  - Change = the alteration in the structure and function of the ecological mosaic over time
- Landscape ecology focuses on the factors controlling the exchanges of energy, materials and organisms (plant or animals) across multiple ecosystems





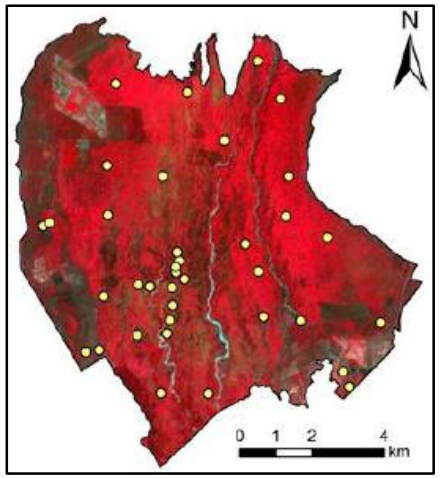


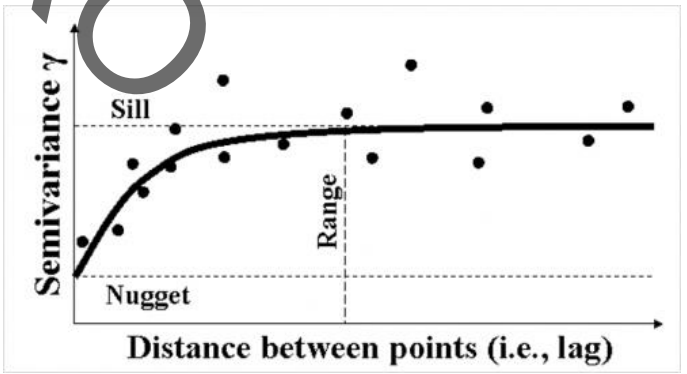
FRAGSTATS:

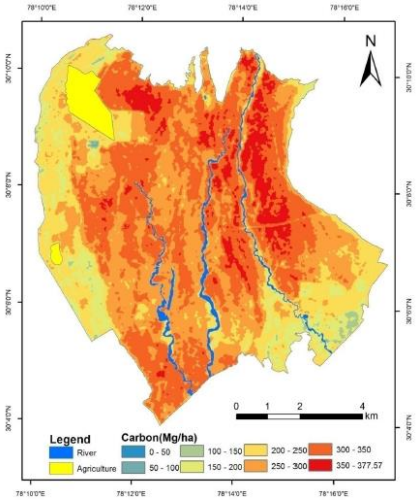
http://www.umass.edu/landeco/research/fragstats

Interpolating sample observations

- Everything is related to everything else. But near things are more related than distant things.
- Raster GIS data provide geographical information for domain of interest, enabling us to check spatial auto-correlation.
- One of the main uses of geostatistics is to predict values of a sampled variable over the whole area of interest.
- Different interpolation technique are available such as Environmental correlation, IDW, Kriging, etc.

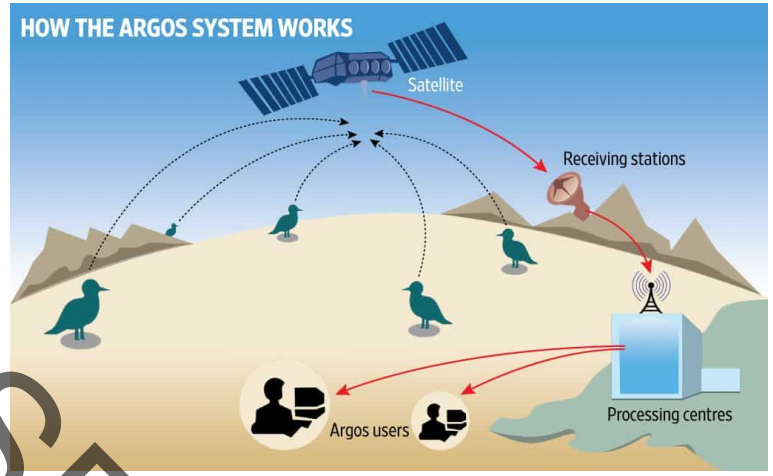






Tracking wildlife dispersal

- Tracking wildlife using Very High Frequency Receiver (VHF) is a very old method;
- Satellite based tracking of animals have recently become very popular.
- Miniaturization of satellite tags/collar is being done for small animals;
- Satellite tracking have revealed several aspects of wildlife ecology (e.g. dispersal distance, ranging pattern, resource utilization pattern, territorial behaviors) and management (e.g. elephant-human conflict).



Amur Falcon

Enabling biodiversity informatics

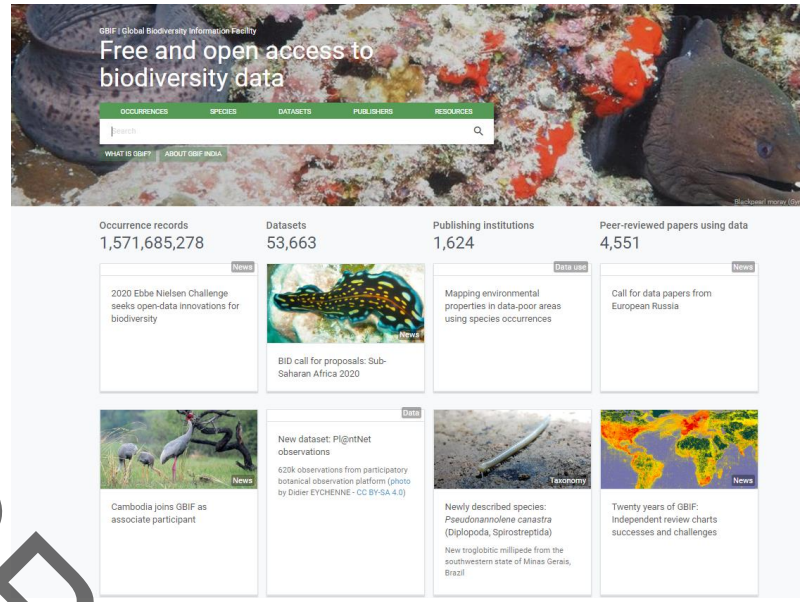
- Many web-based biodiversity databases have come in recent years;
- Biodiversity data collection, organization, administration, visualization, analysis and knowledge products generation has enhanced;
- Taxonomic data standards, Open-source GIS (e.g. OGC) and Raster data standards (e.g. NNRMS-ISRO) have been developed;
- Use of distributed server technology has helped in collocating biodiversity databases of different institutions (IBIN);
- WMS/WFS services for users;
- Shift from commercial to free and open source web server resources;
- Ecosystem/habitat databases (e.g. ISRO-Bhuvan, Global Forest Watch etc.).

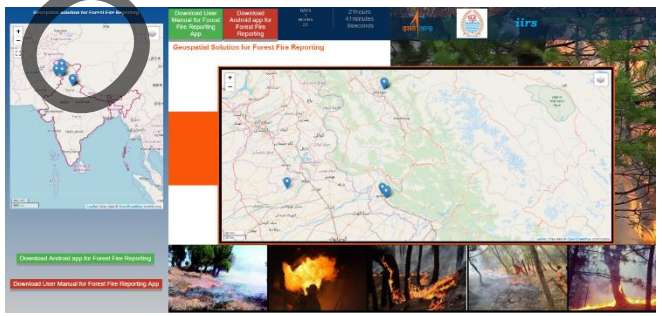
BIS: www.bis.iirs.gov.in

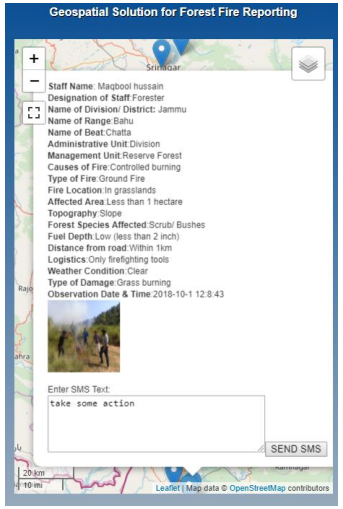
IBIN: www.ibin.gov.in

Enabling citizen science

- Web-portals are allowing collection of ecological data using smart phone devices;
- Herbaria, researchers, institutions are sharing database for use of researchers (GBIF);
- IIRS has developed mobile apps and dashboard for forest fire reporting in J&K state;
- Under Himalayan alpine biodiversity characterization project funded by NMHS, mobile app is being used in laying out field sample plots and inventory of alpine plants data;
- Number of research publications have comes from use of free available biodiversity data in high impact factor journals.







Thank You

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