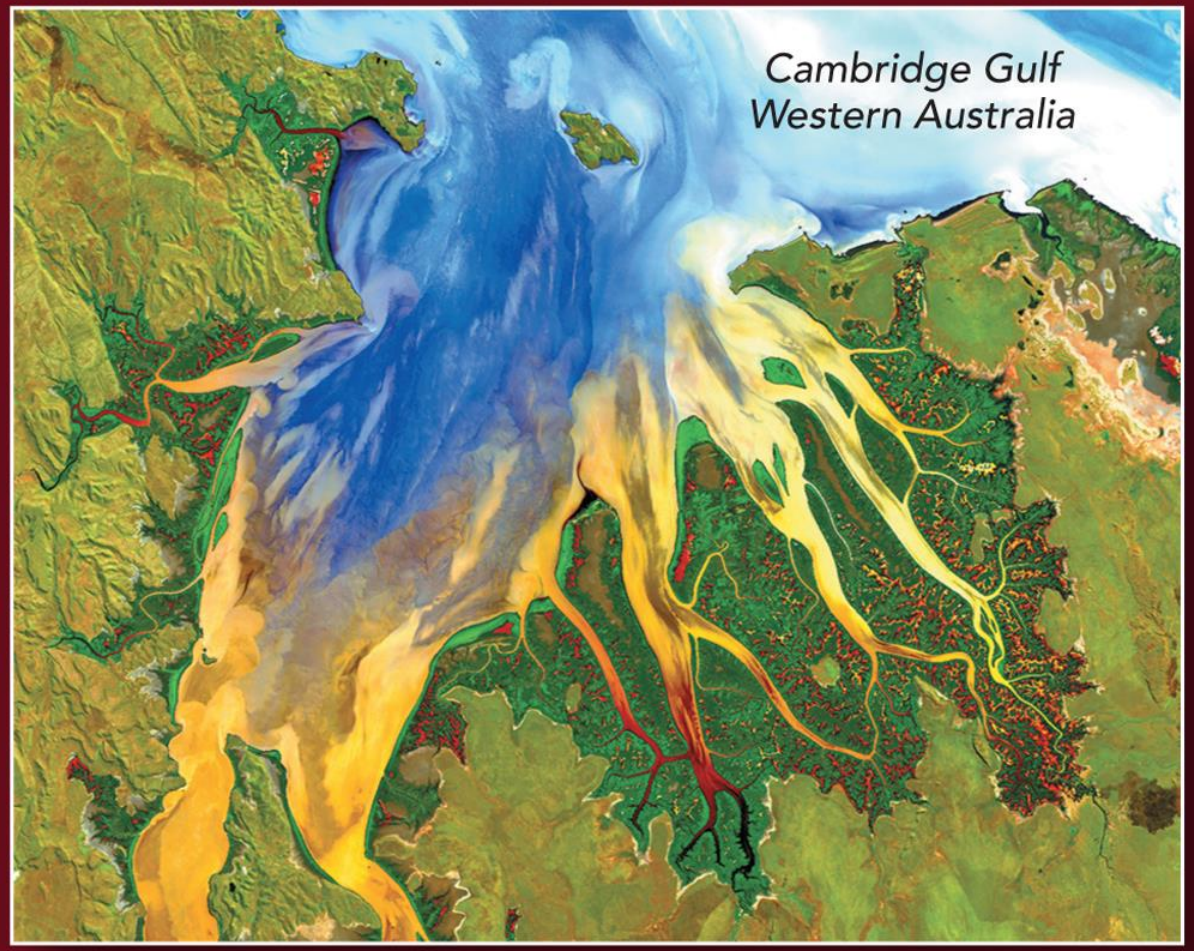
COURSE: SATELLITE IMAGE PROCESSING

LECTURE 12 – Application of Satellite and Airborne Image

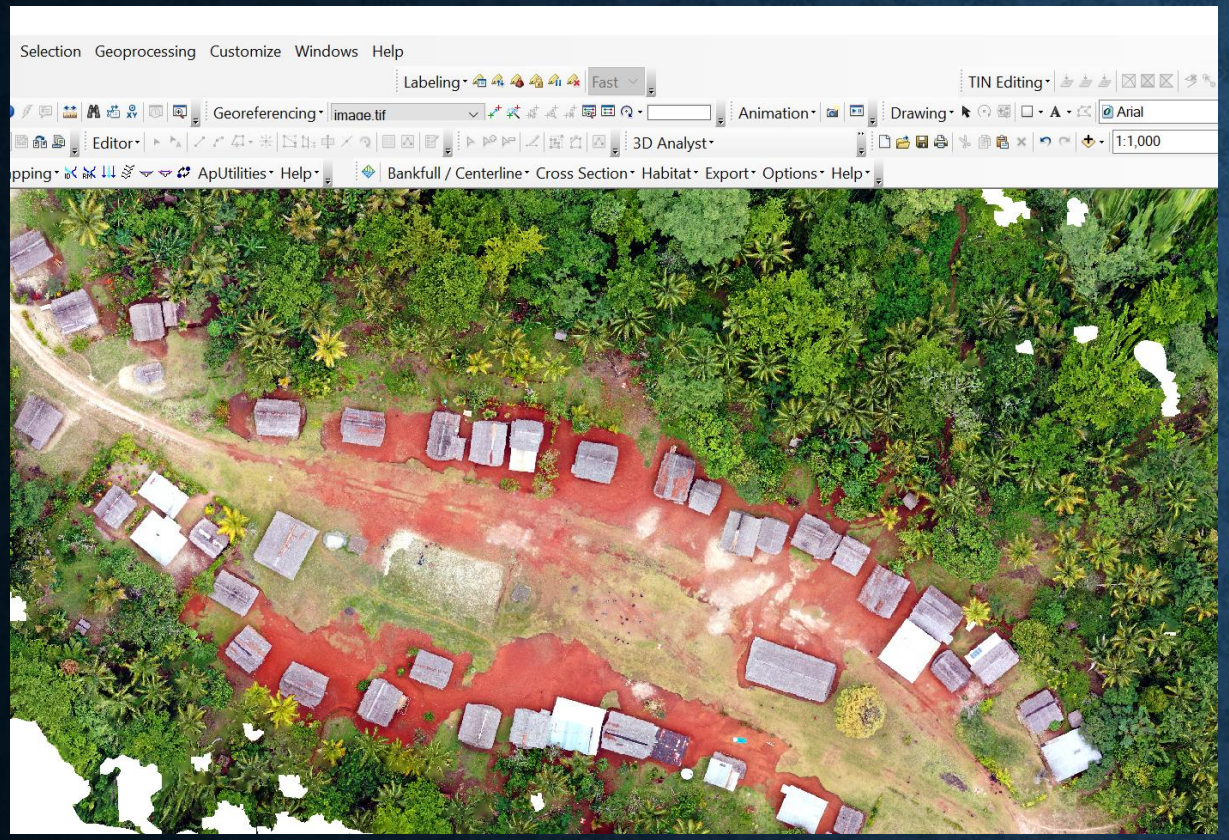
Lecturer: Dr. Tingneyuc Sekac, Ph.D. PNG University of Technology

Satellite Imagery

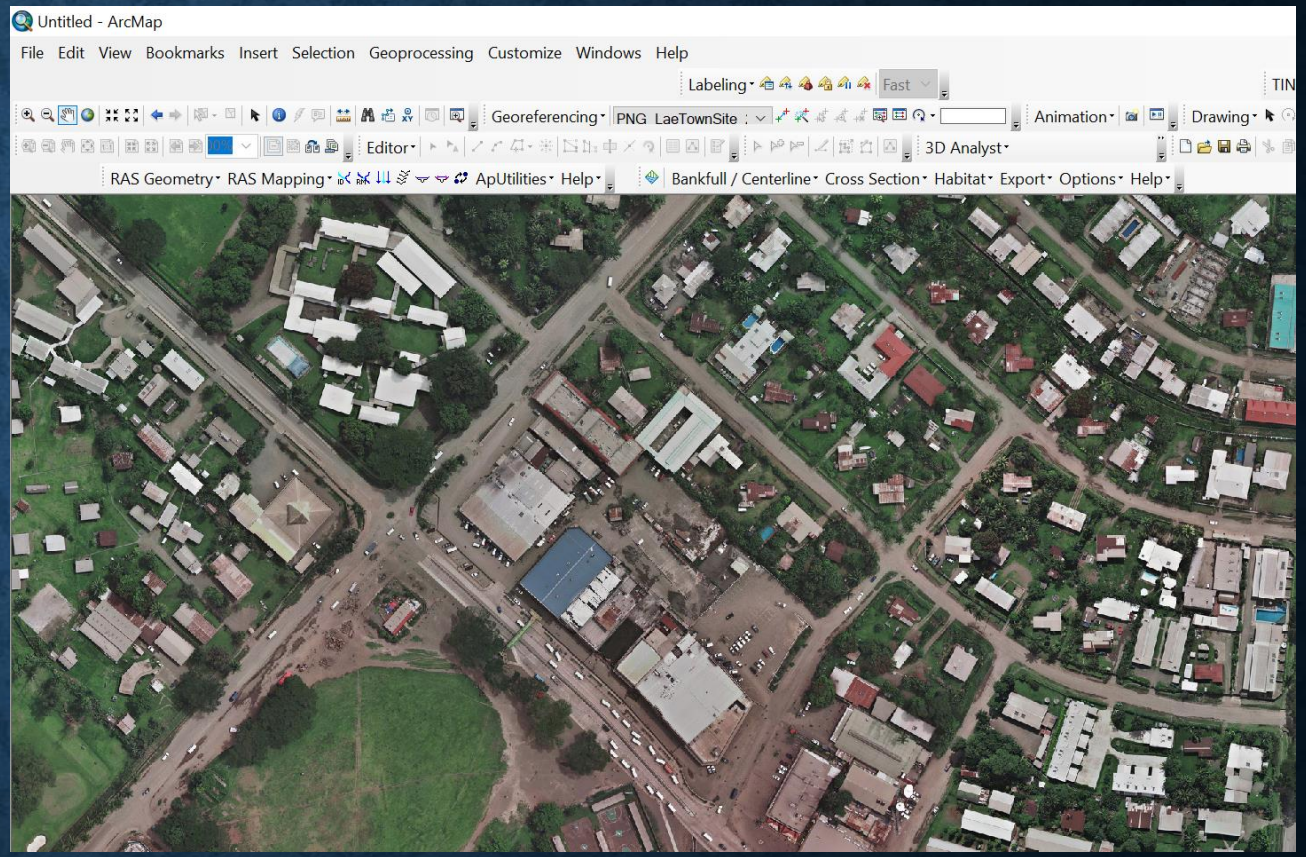


Source: John R. Jesen, 4th Ed, Landsat 8 artist rendition: NASA, 2014

Aerial Imagery



DJI Mavic 2 Drone Imagery Of Kangaruo Village, Finschhafen, Morobe, PNG



LIDAR Othorphoto Of Eriku Town, Lae, Morobe, PNG

Image Source: Tingneyuc Sekac, 2024

Fundamentals of Remote Sensing

- ❑ Electromagnetic Spectrum
- ❑ Sensors and Their Characteristics
- ❑ Image Resolution (Spatial, Temporal, Spectral, Radiometric)
- ❑ Data Acquisition and Processing

Application - Environmental Monitoring and Management

- Deforestation and Forest Management
- Wetlands and Coastal Monitoring
- Wildlife Habitat Mapping
- Water Quality Assessment
- Disaster Monitoring and Management (Floods, Earthquakes, Hurricanes)

Application - Environmental Monitoring and Management

- ❑ Deforestation and forest management:

- for instance, utilize satellite imagery to track changes in forest cover, monitor illegal logging activities, and assess the impact of conservation efforts.

- ❑ Wetlands and coastal monitoring:

- Study habitat changes, erosion patterns, and the effects of climate change.

- ❑ Wildlife habitat mapping:

- Identify and protect critical habitats for endangered species.

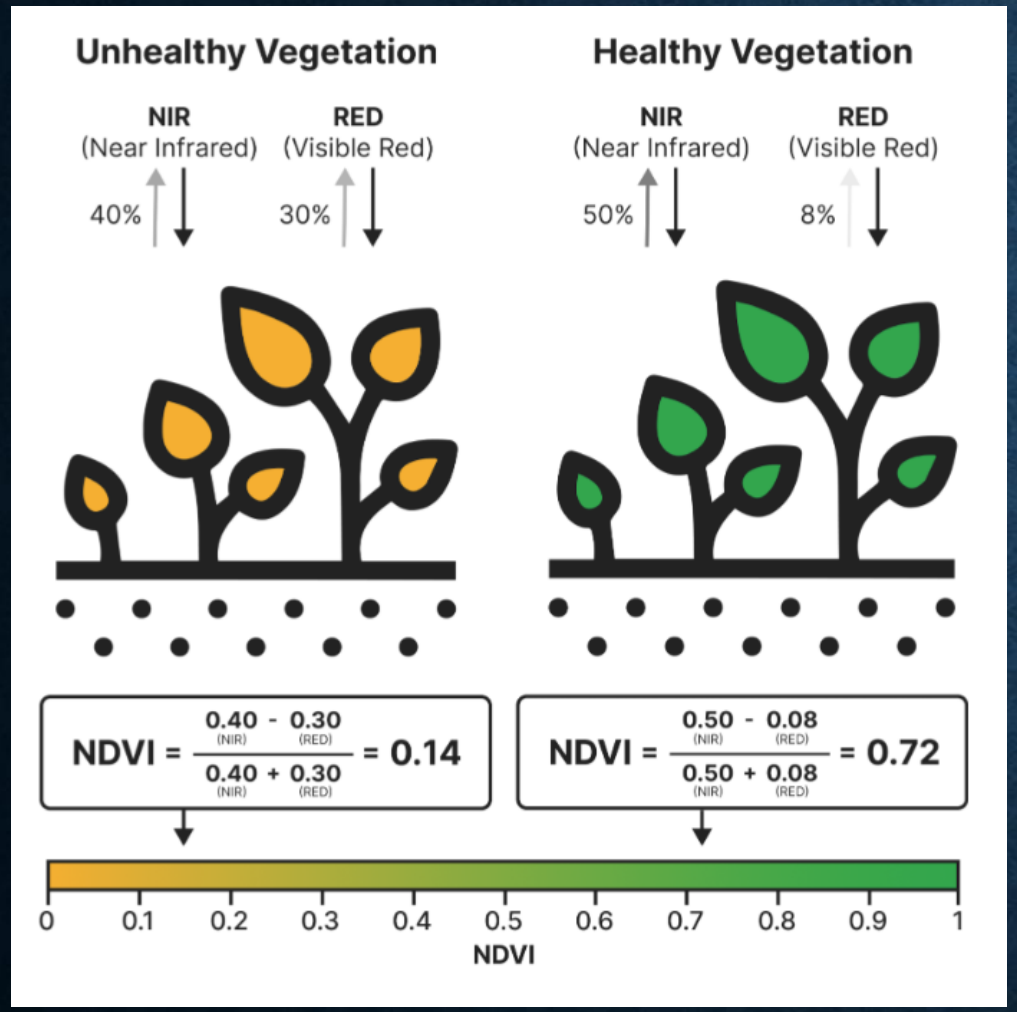
Application - Environmental Monitoring and Management

- Detecting and combating illegal logging activities.
- By continuously scanning vast forested regions, satellites can identify unauthorized clear-cutting, logging trails, and timber extraction operations.
- The transparency provided by satellite monitoring promotes responsible forest management and discourages illegal activities.

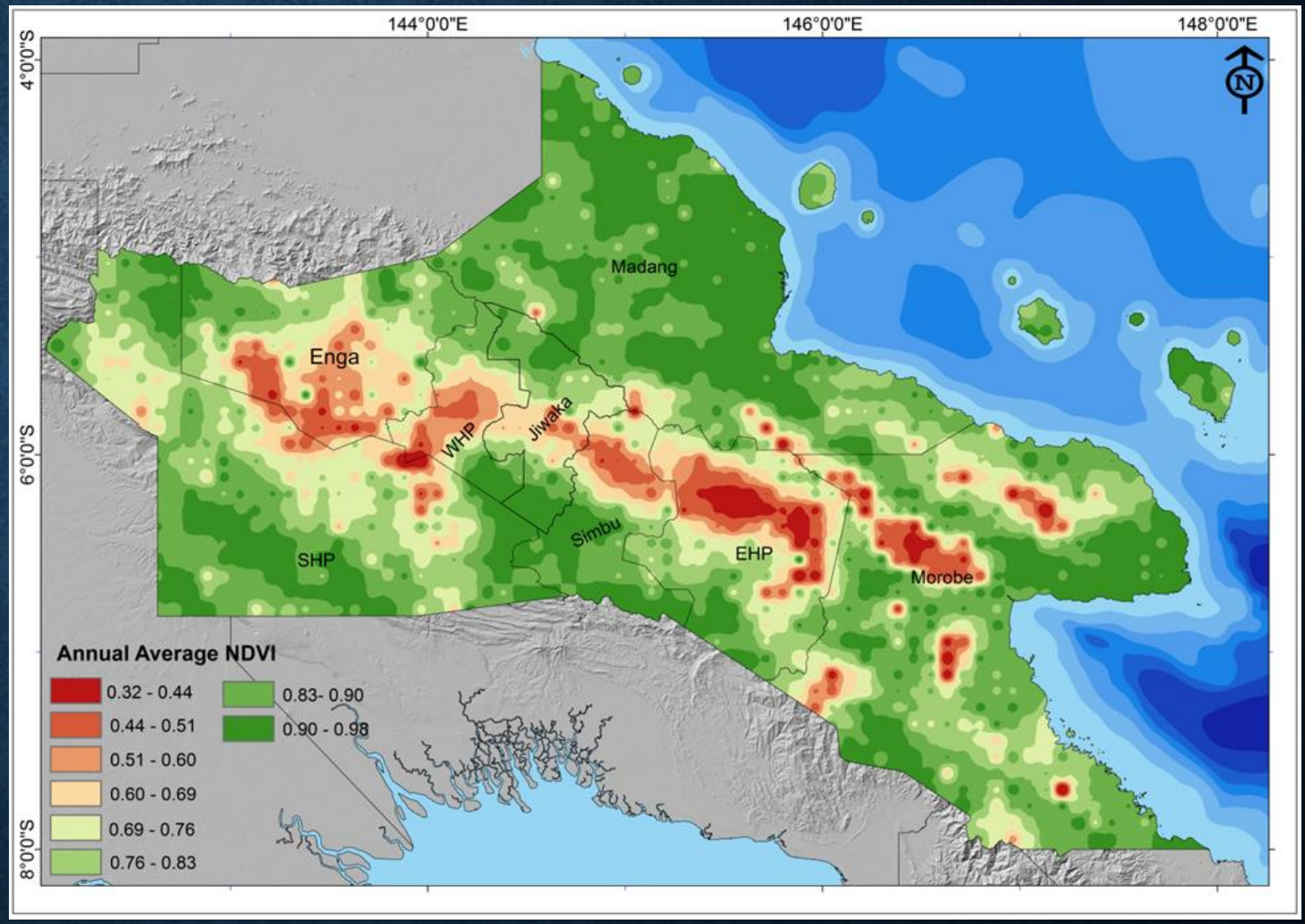
- GIS solutions integrated with satellite imagery provide accurate forest mapping and inventory data.
- By leveraging remote sensing technologies and geospatial analysis, scientists can estimate forest biomass, measure carbon stocks, and identify areas of high conservation value.

Source: SWIFT GEOSPATIAL; Retrieved; https://swiftgeospatial.solutions/deforestation-monitoring/

Application - Environmental Monitoring and Management



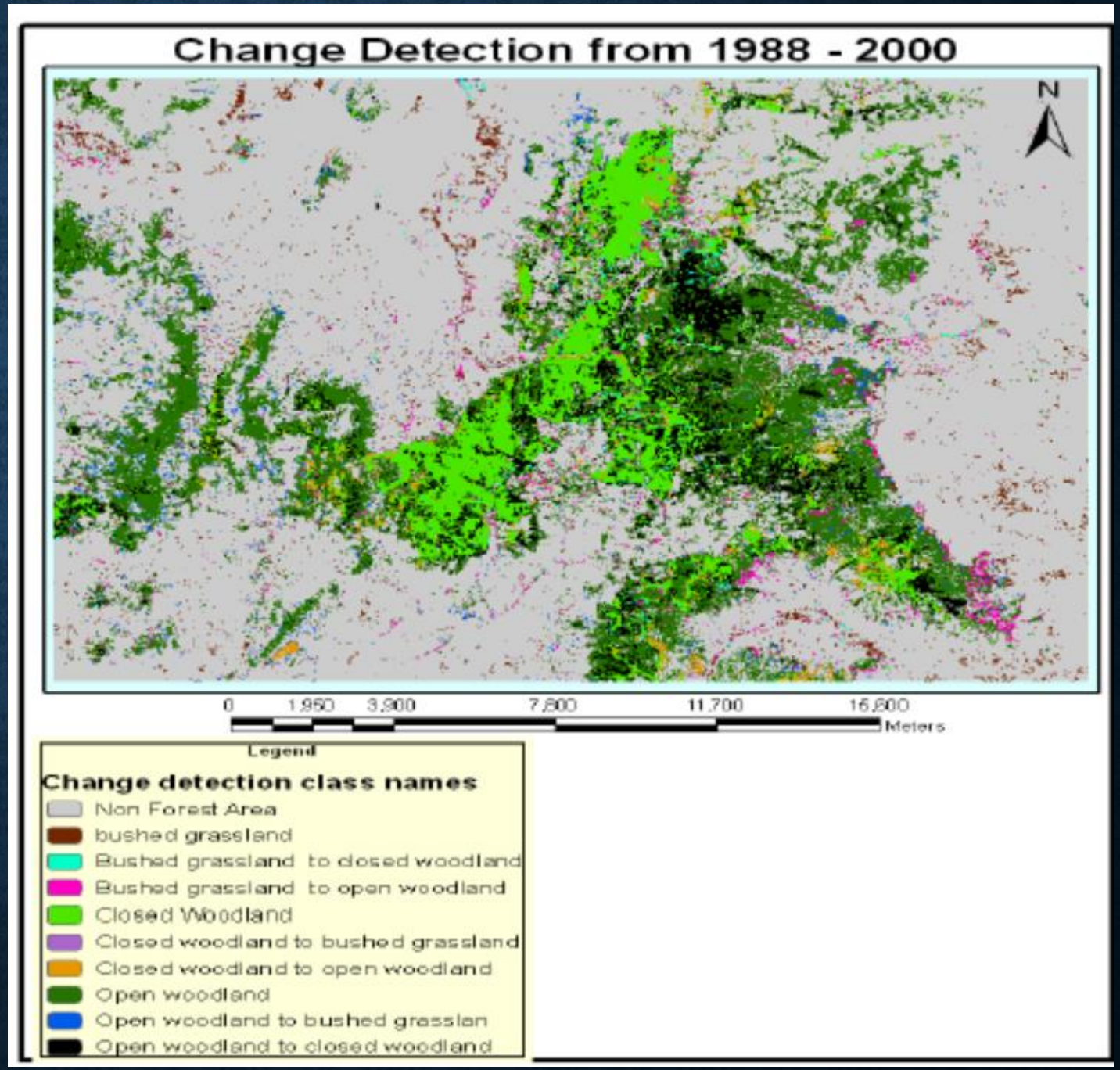
Source: https://www.streambatch.io/knowledge/ndvi-from-first-principles



Source: T.Sekac, et al (2022)

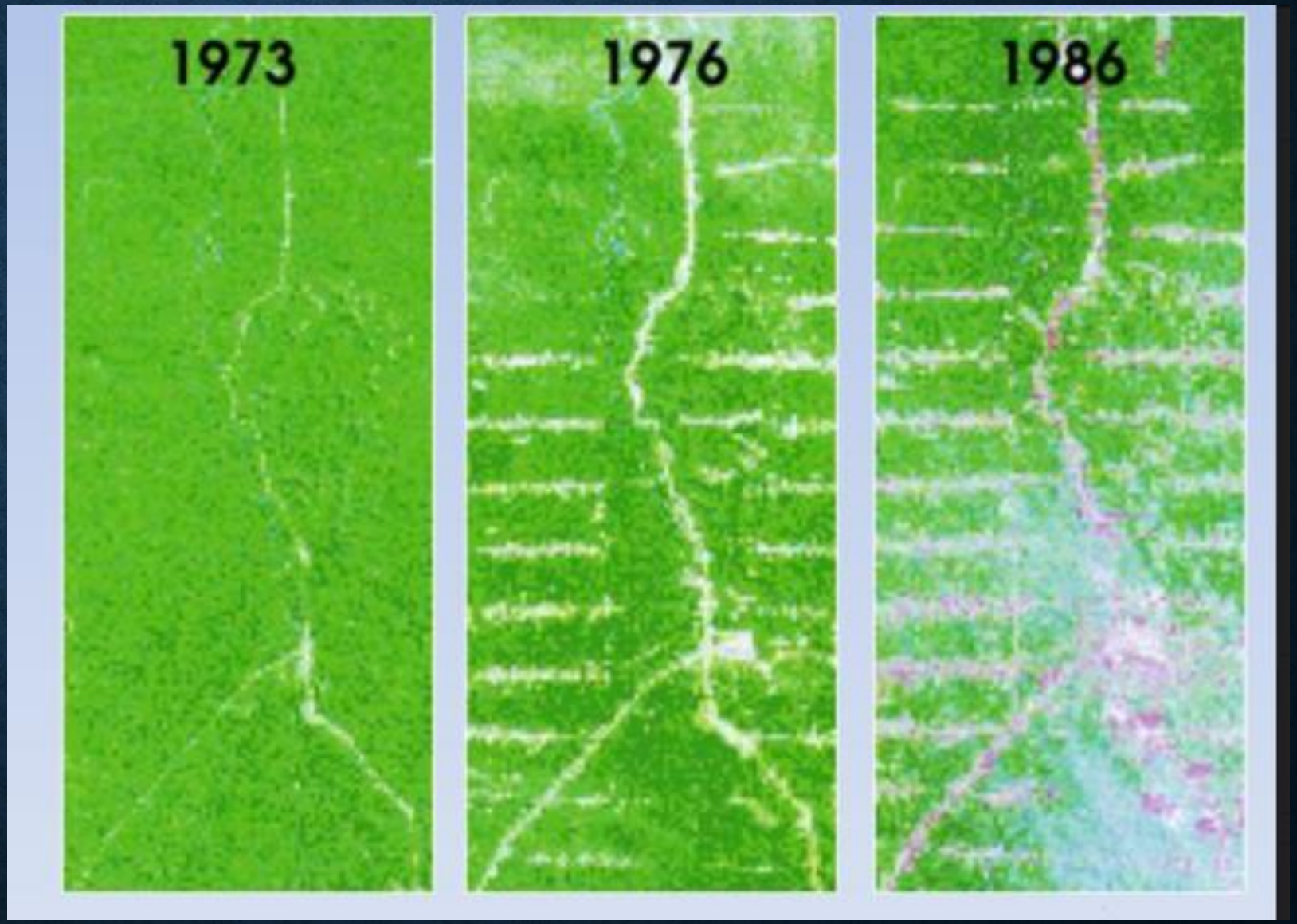
NDVI = NIR - RED/NIR +RED

Application - Environmental Monitoring and Management



Source: Kashindye Almas, 2013

Application - Environmental Monitoring and Management

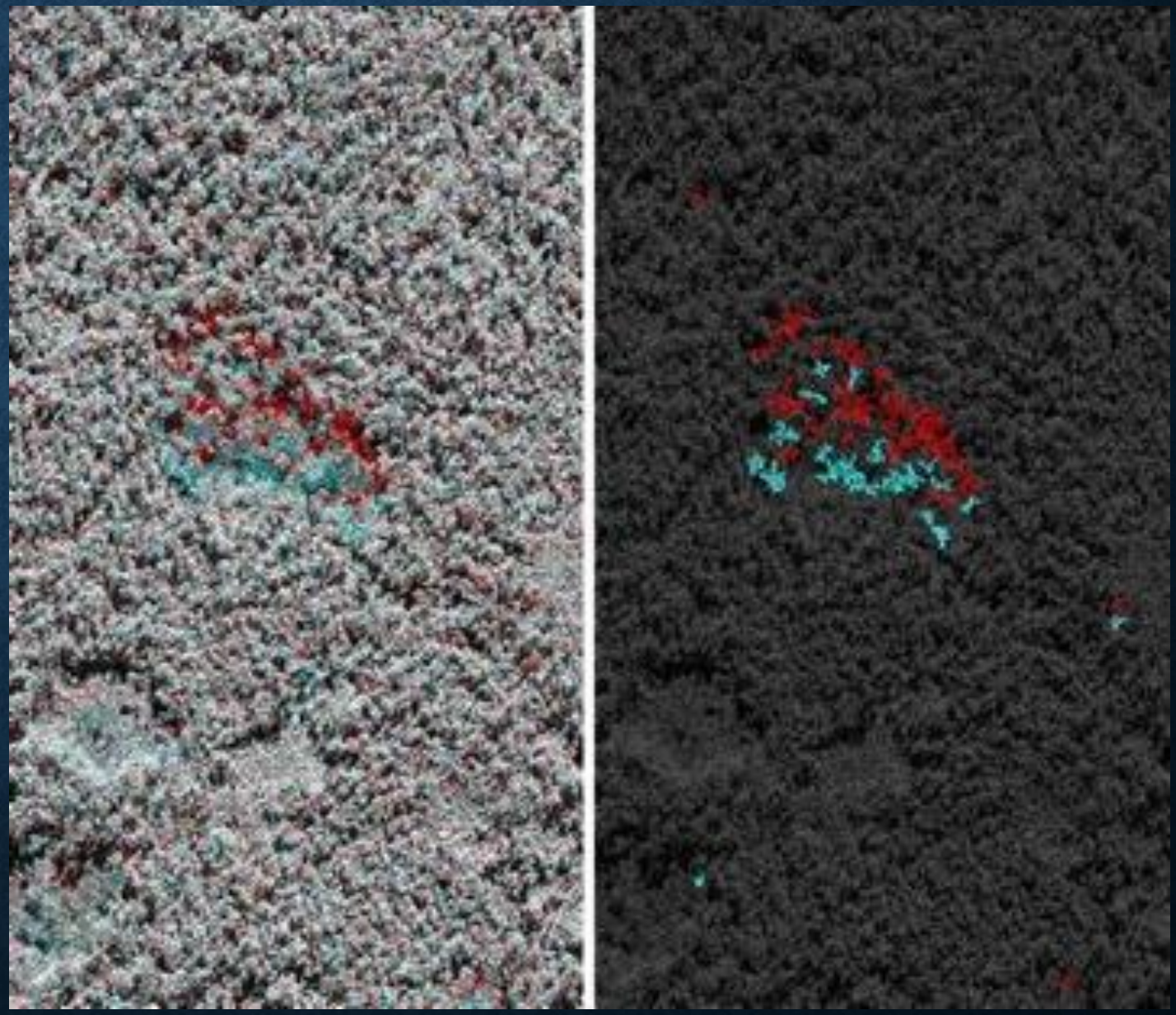


Source: Md. Bodruddoza Mia

Application - Environmental Monitoring and Management

TerraSAR-X Spotlight imagery (Oct 2013 in red, Jan 2014 in cyan) and automated change mapping result for Calha Norte, Brazil, showing removal of individual trees through detection of disappearing tree crowns (red) and radar shadows (cyan)

; Courtesy of [36]



Source: Hoekman D, 2016

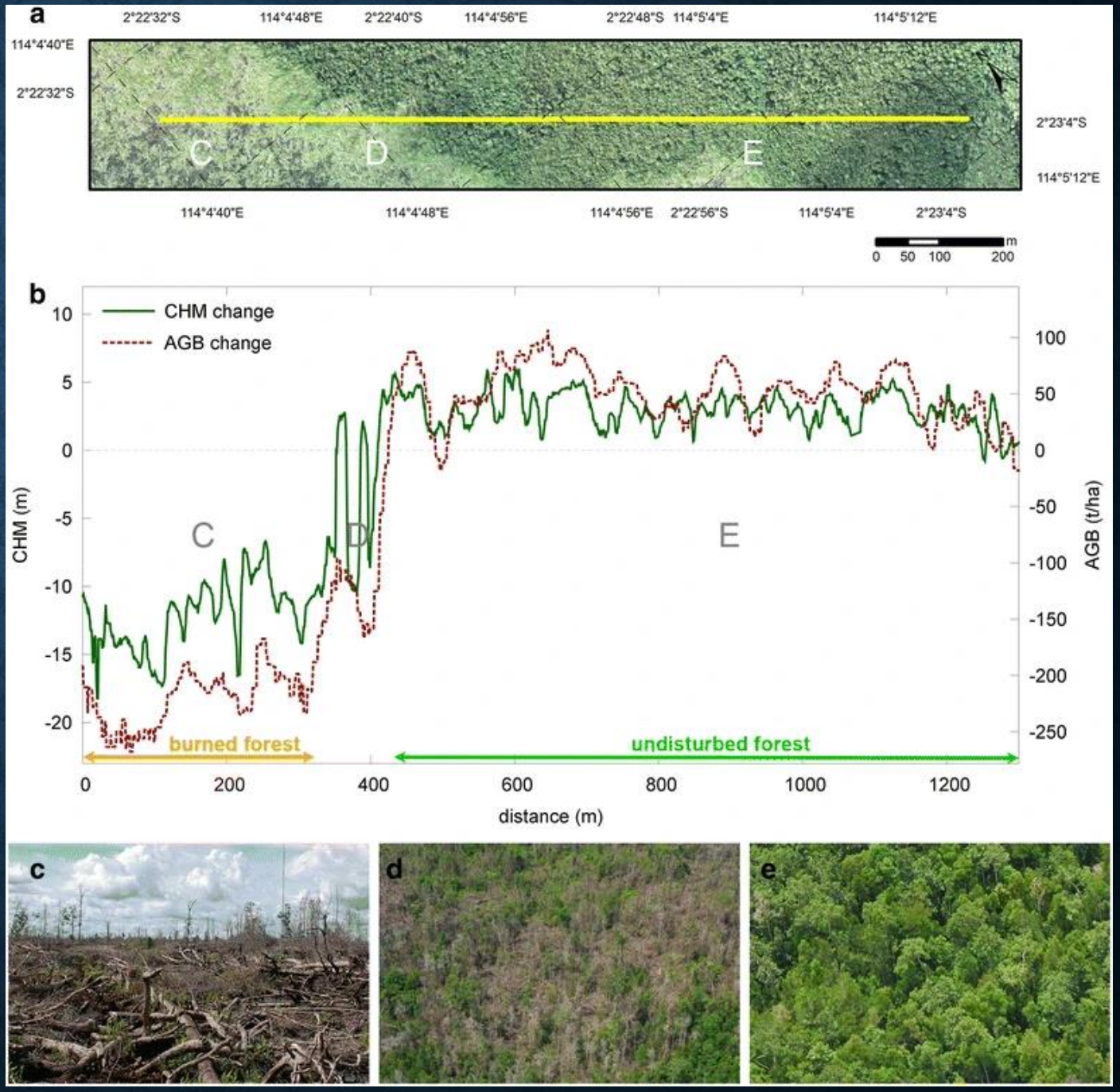
Application - Environmental Monitoring and Management

Use of multi-temporal LiDAR to quantify canopy height and AGB dynamics in tropical peatland forest:

(a) Transect through burnt and adjacent undisturbed peat swamp forest.

(b) Changes in canopy height and AGB associated with different forest conditions;

- (c) burnt forest,
- (d) transition area and
- (e) undisturbed forest



Source: Englhart S, et al, 2013

Application - Agriculture and Forestry

- Crop Health Monitoring
- Precision Agriculture
- Soil Moisture and Irrigation Management
- Forest Health and Inventory
- Pest and Disease Detection

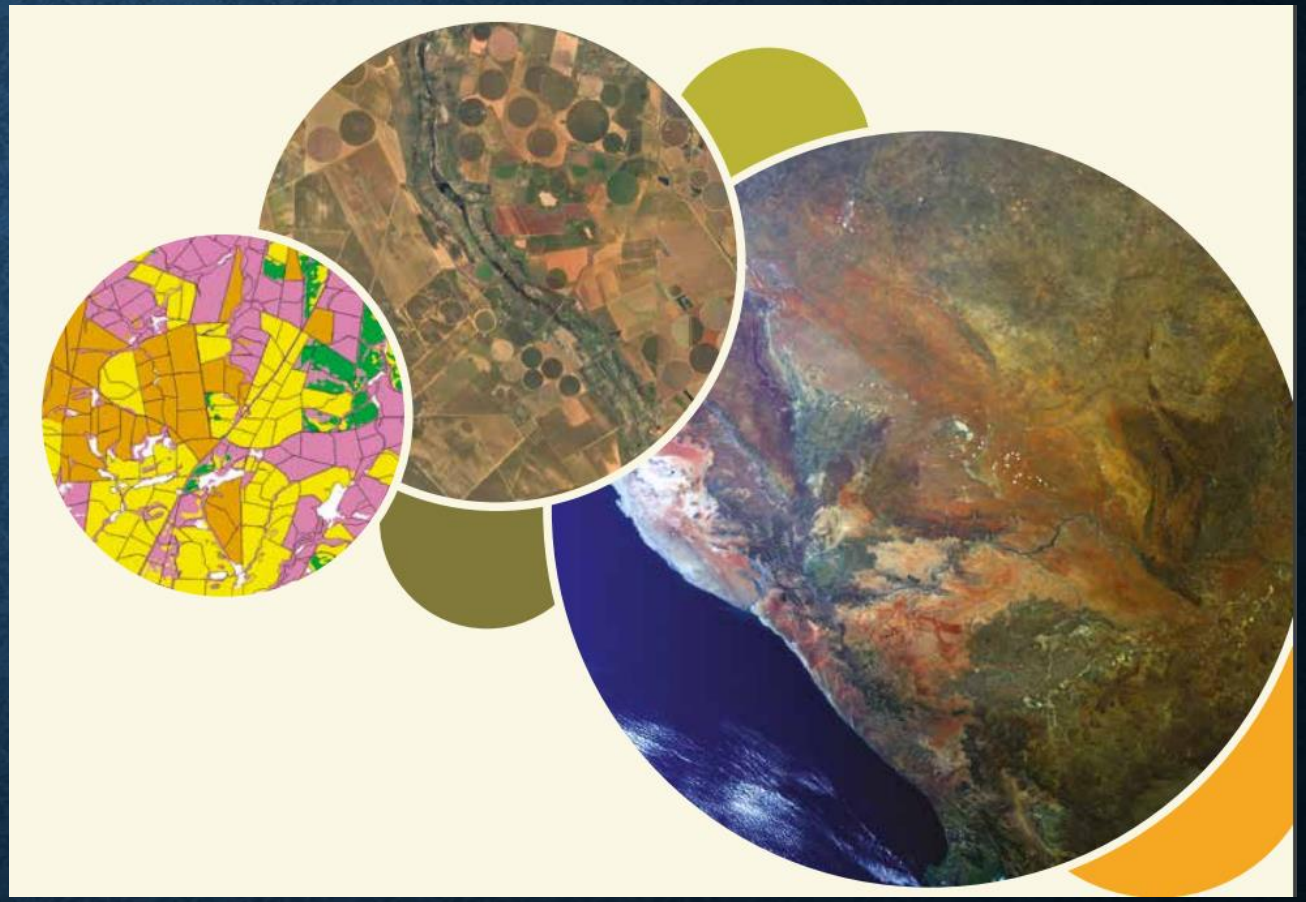


Image Source: FAOUN

Source: Md. Bodruddoza Mia

Application – Agriculture

- Agricultural applications of remote sensing include the following:
- crop type classification
- crop condition assessment
- crop yield estimation
- mapping of soil characteristics
- mapping of soil management practices
- compliance monitoring (farming practices).

Source: CCRS-tutorial

Application – Agriculture and Forest

- In agriculture, remote sensing technologies enable precision farming by providing detailed information on crop health, yield, soil conditions, irrigation needs etc…
- Satellite and UAV imagery help farmers optimize inputs, reduce costs, and increase yields.
- In forestry, remote sensing is used for forest inventory, health monitoring, and detecting pest infestations, thereby supporting sustainable forest management practices.

Source: Md. Bodruddoza Mia

Application – Agriculture and Forest

Types of Remote Sensing in Agriculture

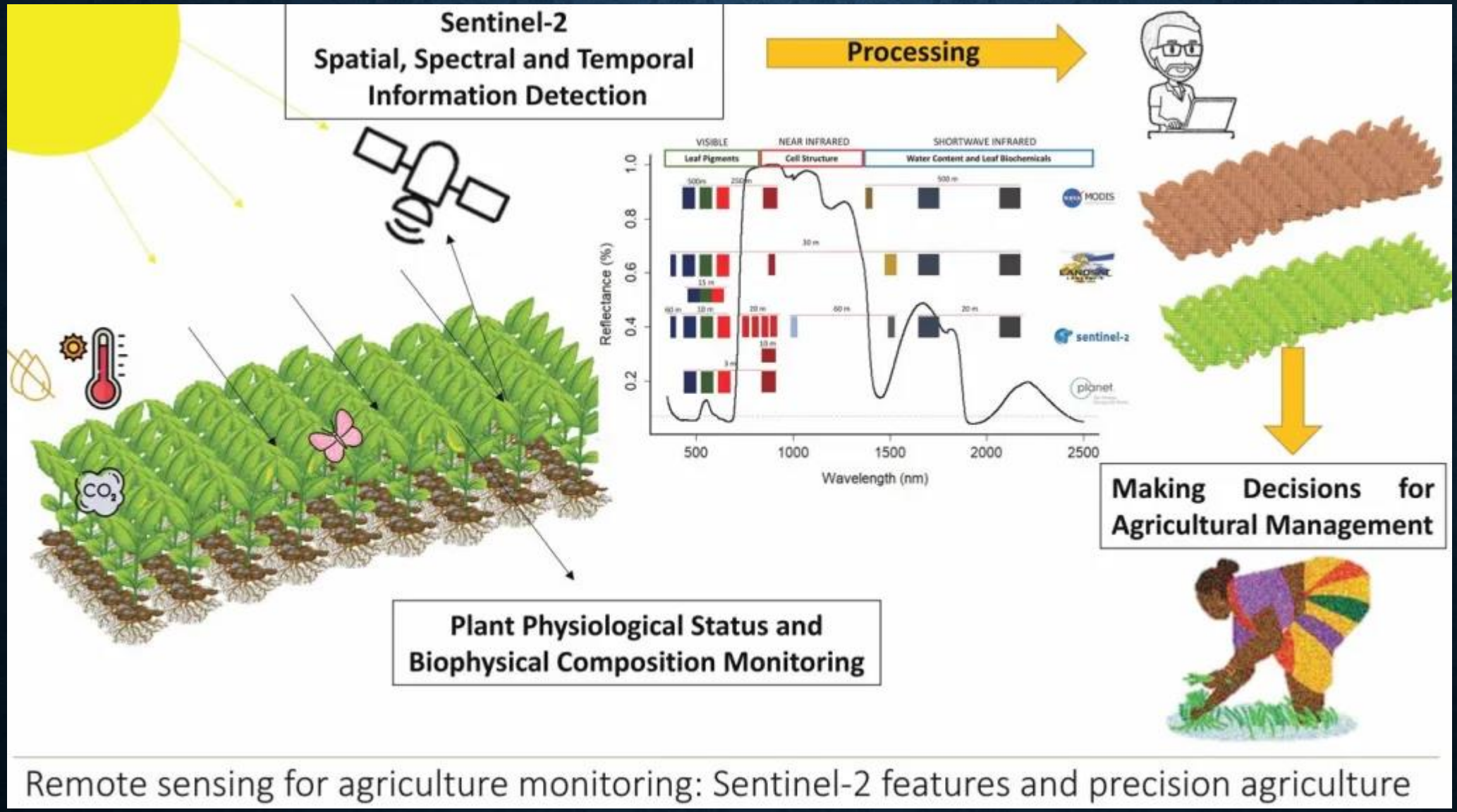
Source: https://geopard.tech/blog/types-of-remote-sensing-in-agriculture/

Application – Agriculture and Forest

Creating Crop Databases

Image Source: FAOUN

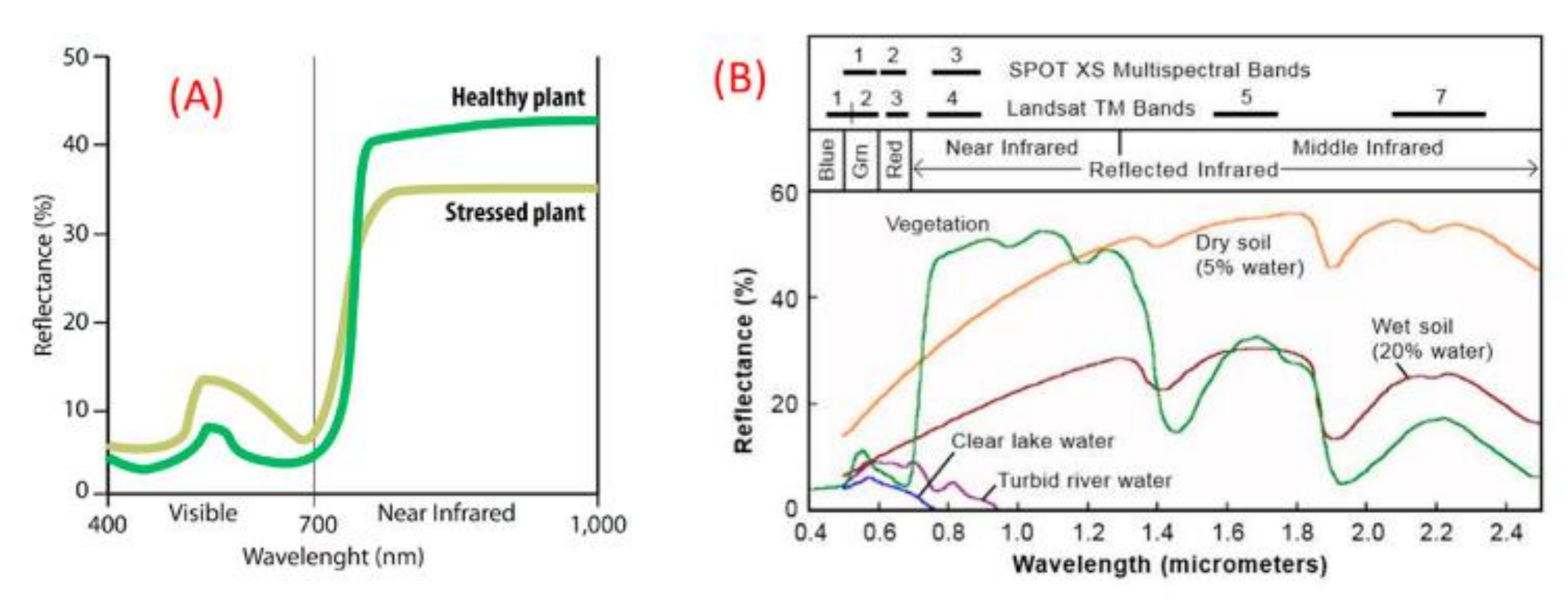
Application – Agriculture



Source: https://geopard.tech/blog/types-of-remote-sensing-in-agriculture/

Application – Agriculture and Forest

Reflectance spectrum of (A) a healthy and a stressed plant (B) soil, water, and vegetation



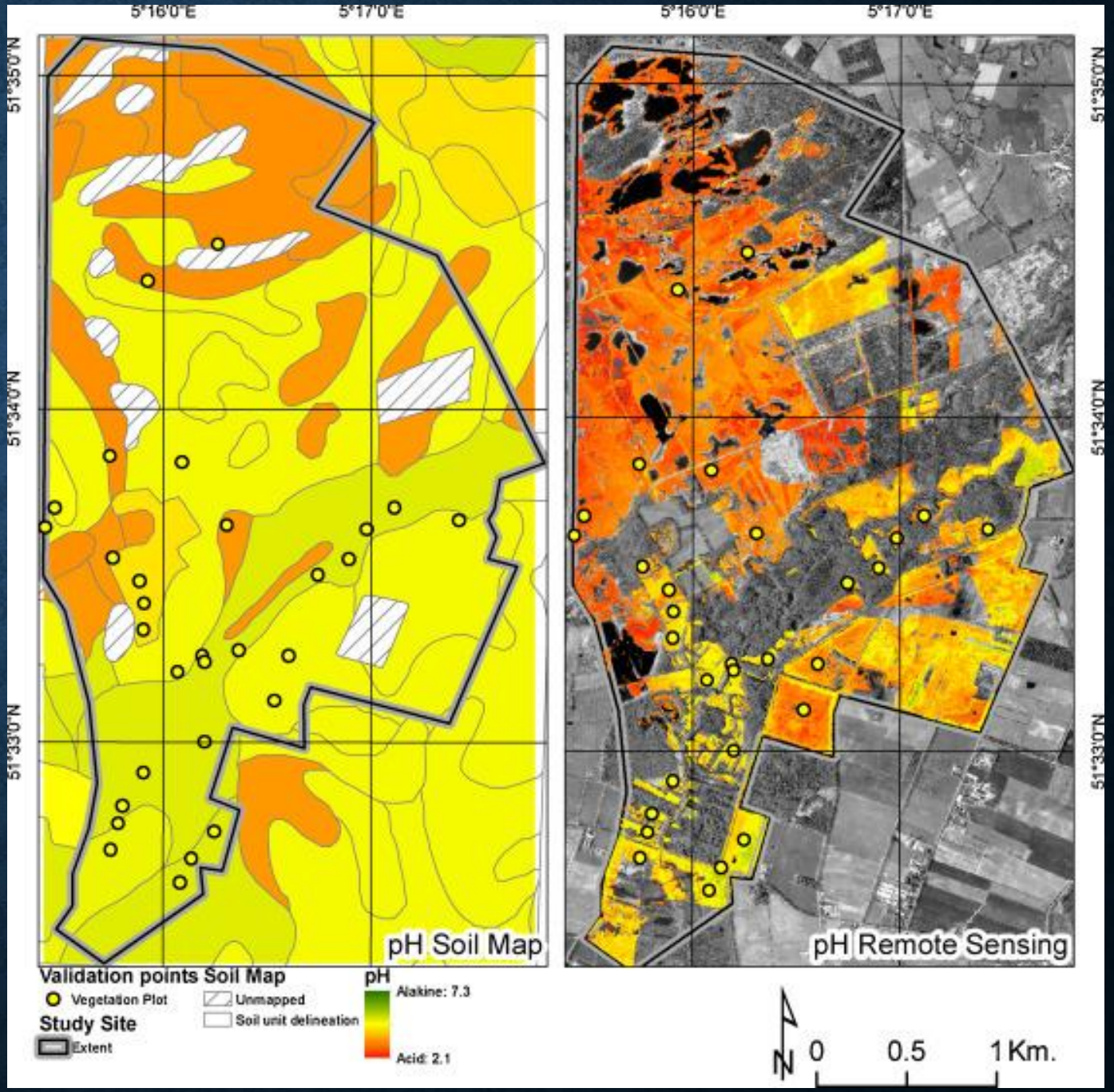
The red-edge NDVI (RNDVI), normalized difference red edge (NDRE), and red-edge difference vegetation index (REDVI) have been shown to outperform the NDVI in estimating plant nutrient status, leaf area index, and biomass in dense vegetation conditions.

Source: Bibhuti Bhusan; Govaerts and Verhulst (2010), Mondal (2009)

Application - Agriculture

Farming soil observed using remote sensing

For precision agriculture, monitoring the soil is essential. Some critical soil parameters to optimize crop management include soil organic matter (SOM), soil texture, soil pH level, moisture content, etc.



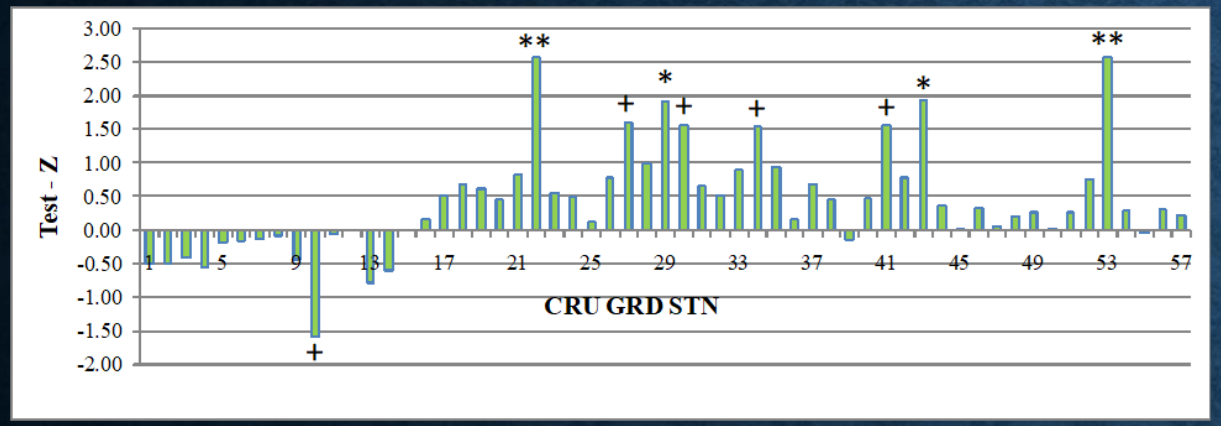
Source: Md. Bodruddoza Mia

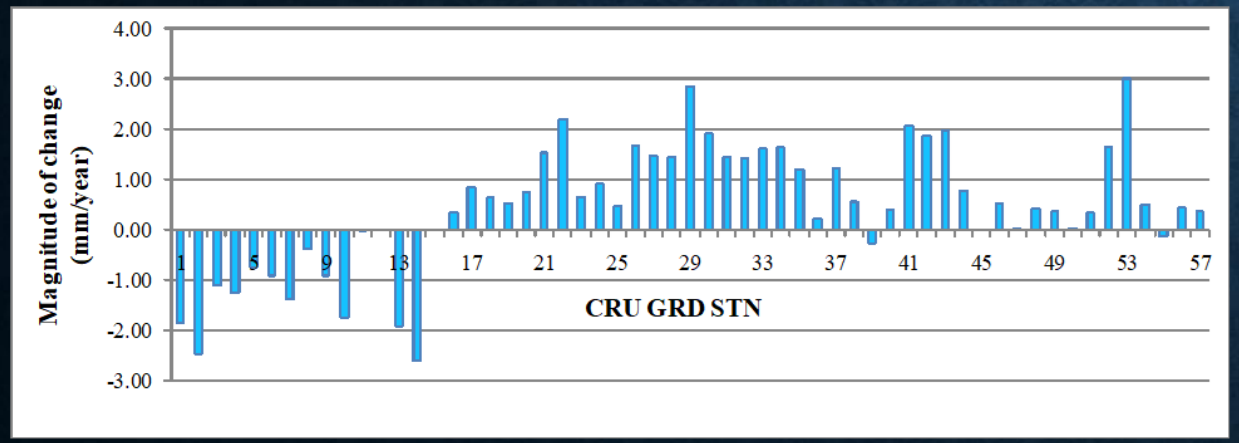
Application – Climate Change and Weather Forecasting

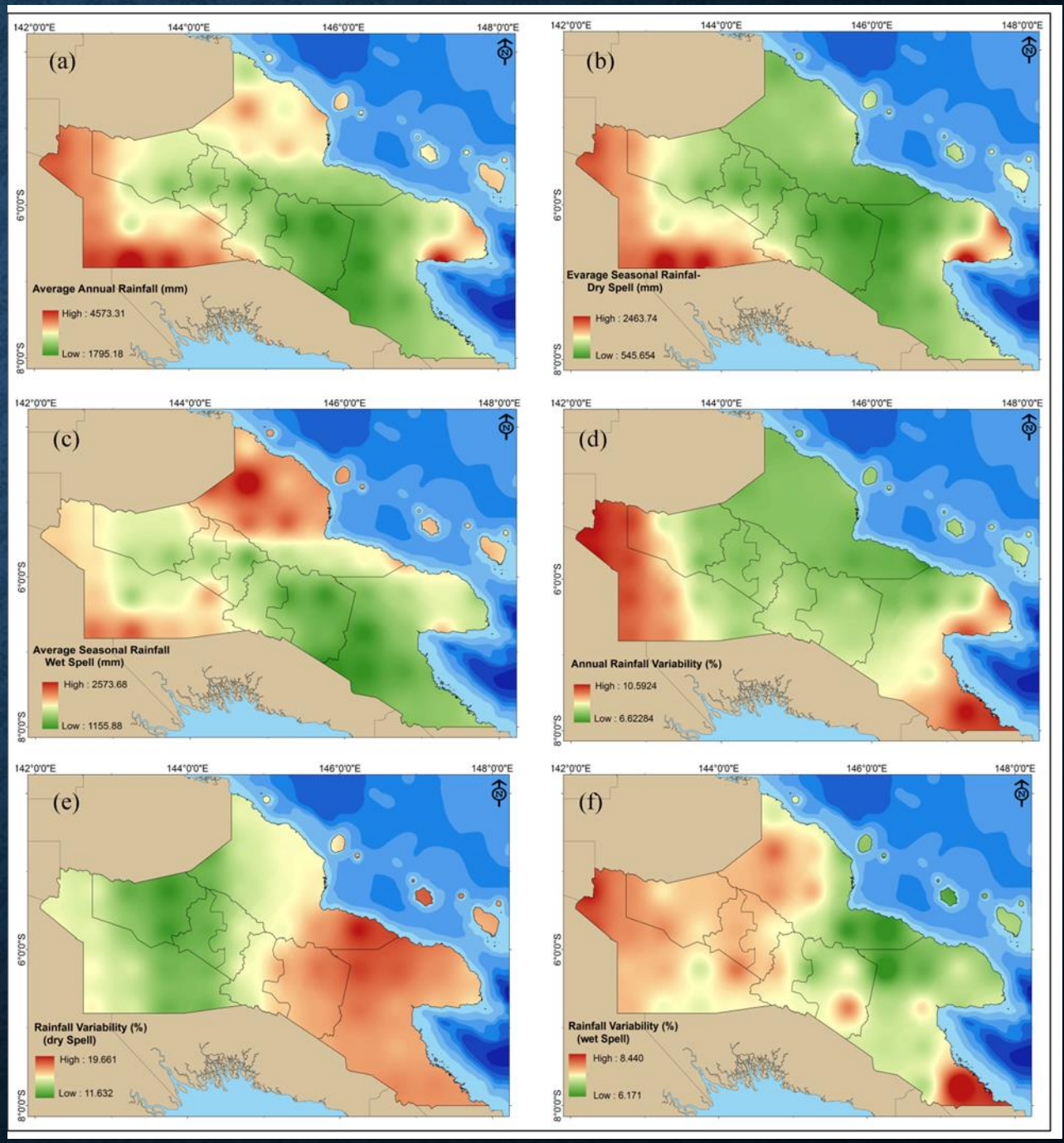
- Climate Monitoring and Modeling
- Temperature and Precipitation Analysis
- Sea Level Rise and Glacial Monitoring
- Extreme Weather Events Prediction
- Carbon Emission and Air Quality Analysis

Source: Md. Bodruddoza Mia

Application – Climate Change and Weather Forecasting

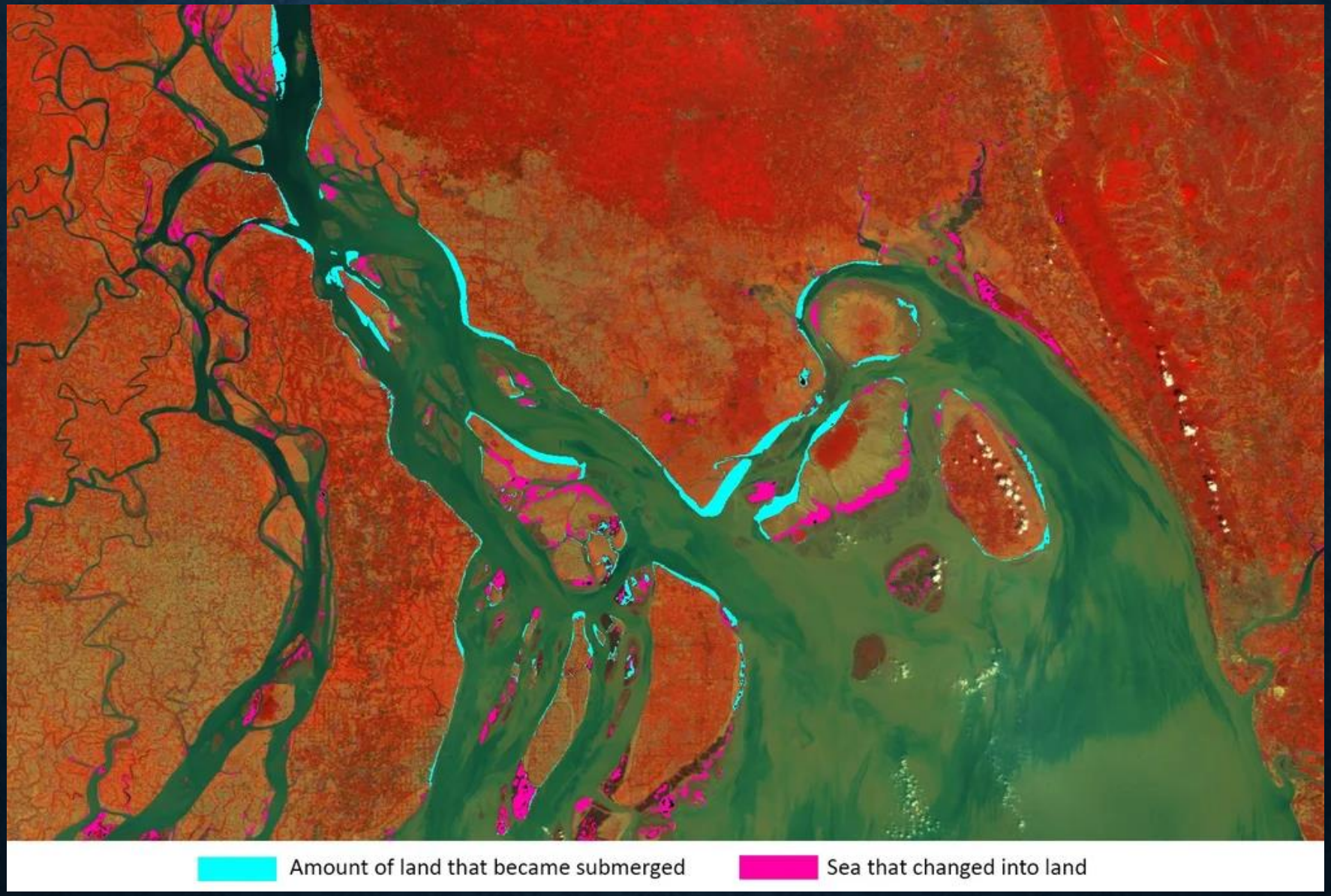






Source: T.Sekac et al (2022)

Application – Sea Level Rise monitoring



Source: by Erwin Wolters, (2017); Retrieved: https://blog.vito.be/remotesensing/monitoring-global-sea-level-rise-using-satellite-data

Remote Sensing in Natural Hazard and Disaster Management

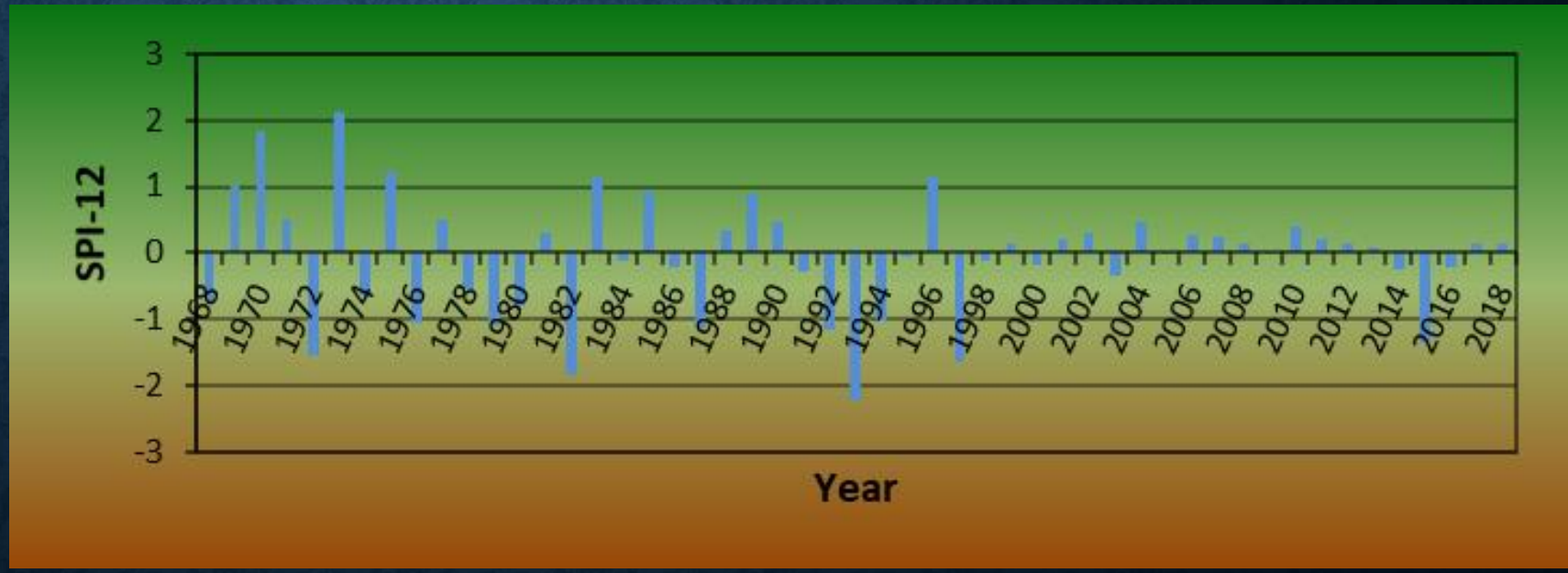
- Remote sensing provides critical data for the detection, monitoring, and management of natural disasters.
- It aids in disaster preparedness, response, and recovery efforts by offering timely and accurate information.

Drought hazard characterization

Standardized Precipitation Index

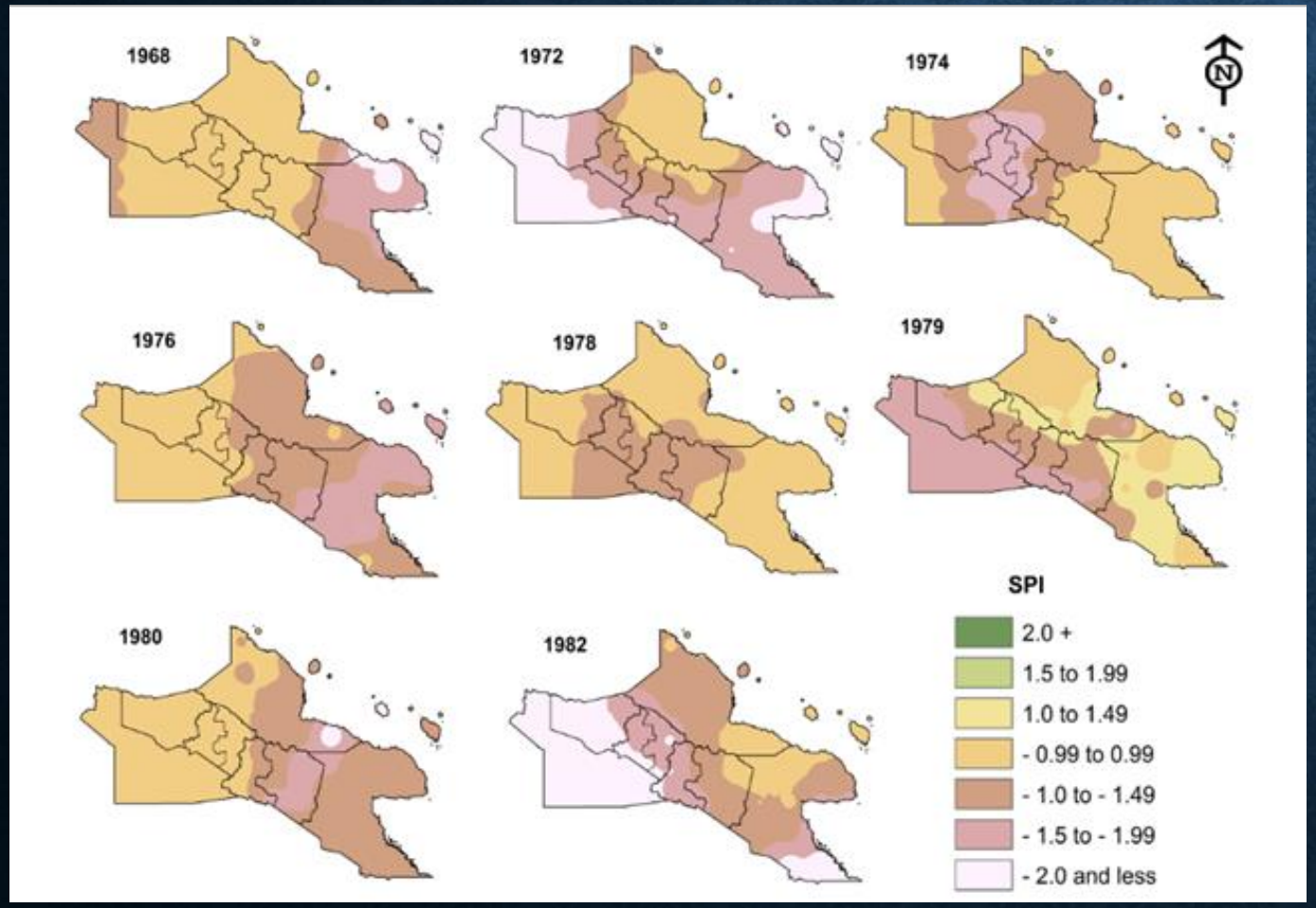
SPI Value Ranges	Category (representations)
+ 2 to more	Extremely wet
1.5 to 1.99	Very wet
1.0 to 1.49	Moderately wet
-0.99 to 0.99	Near Normal
-1.0 to (-1.5)	Moderately dry
-1.5 to (-1.99)	Severely dry
-2 to less	Extremely dry

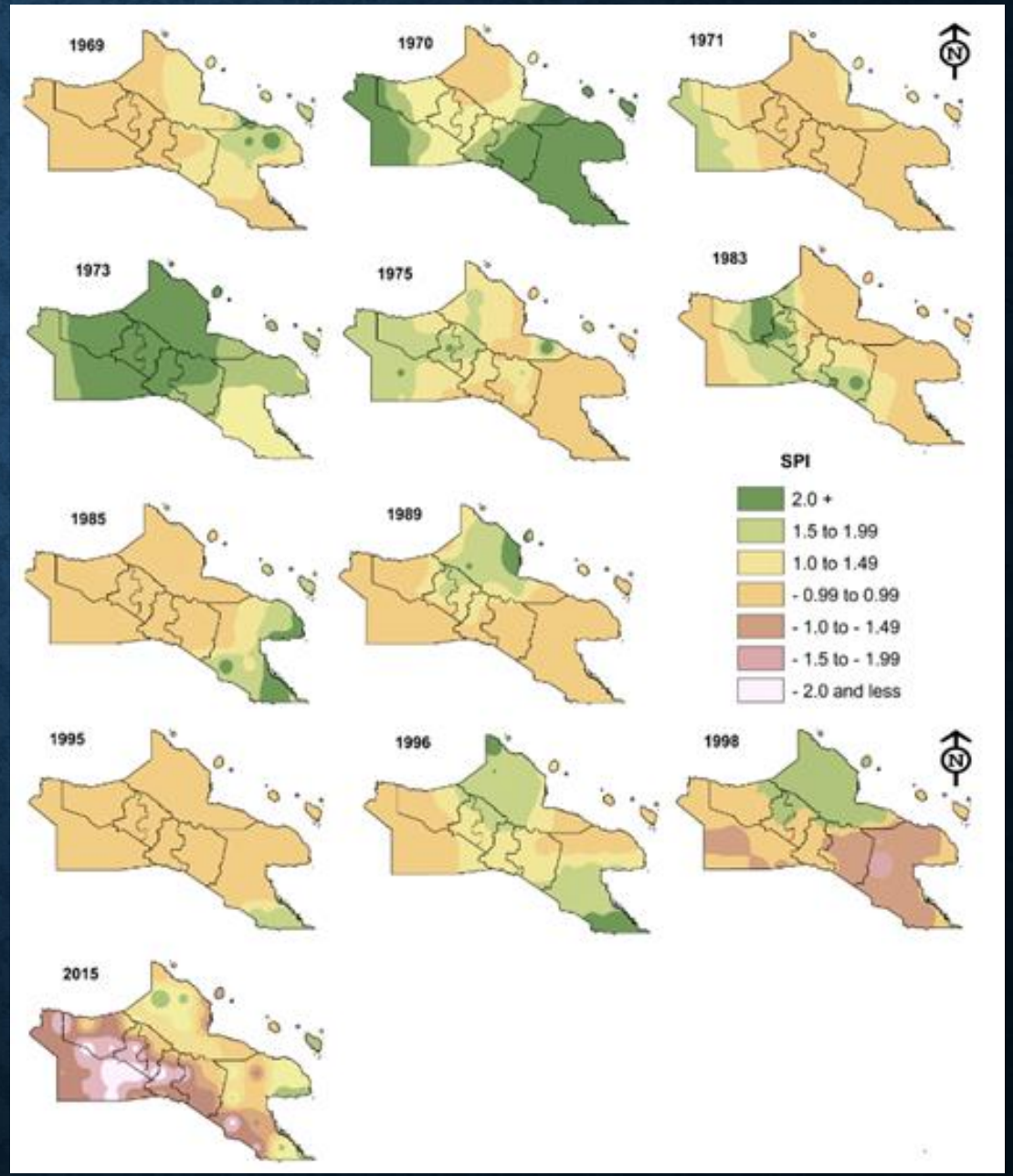
Table Spurce: McKee et al., (1993)



Source: T. Sekac (2022)

Standardized Precipitation Index





Source: T. Sekac (2022)

Drought Hazard and Vulnerability Assessment and Mapping

Vegetation Condition Index

Drought grades defined by Vegetation Condition Index (VCI).

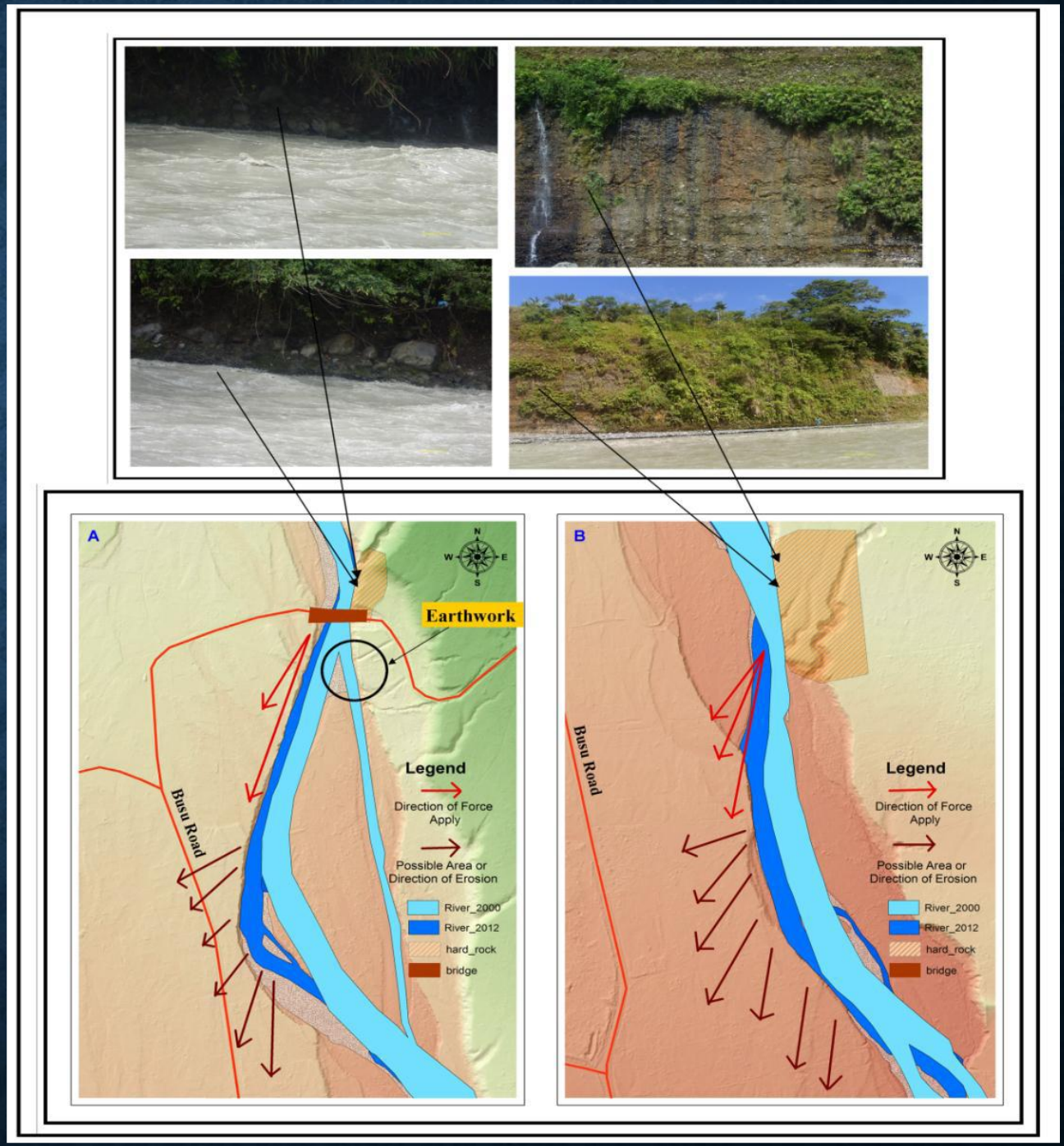
Grade Types VCI (%)

1. Normal >50%
2. Drought 35–50%
3. Severe drought <35%

Source: Baniya, B., (2019)

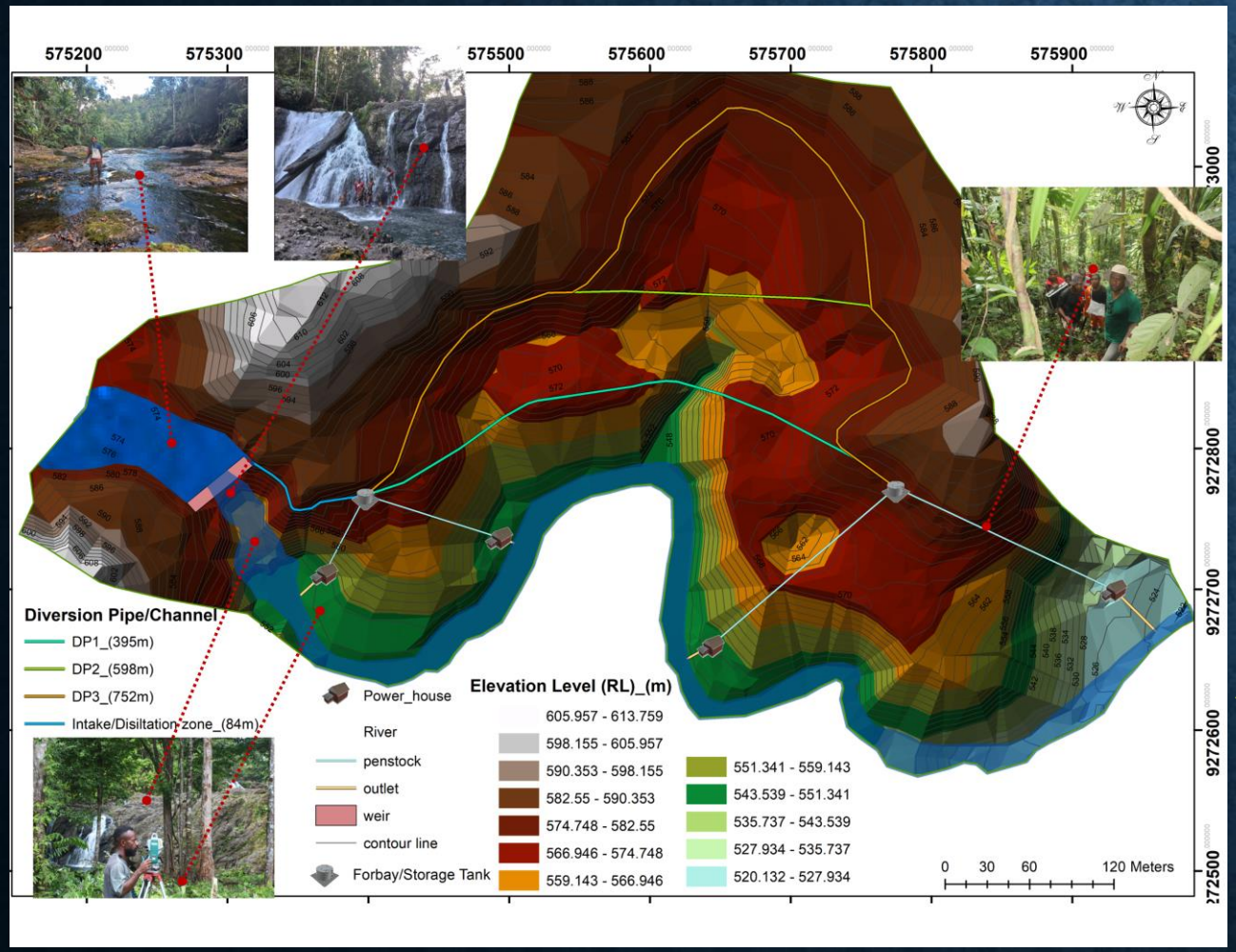
Source: DUTRA et al. (2021)

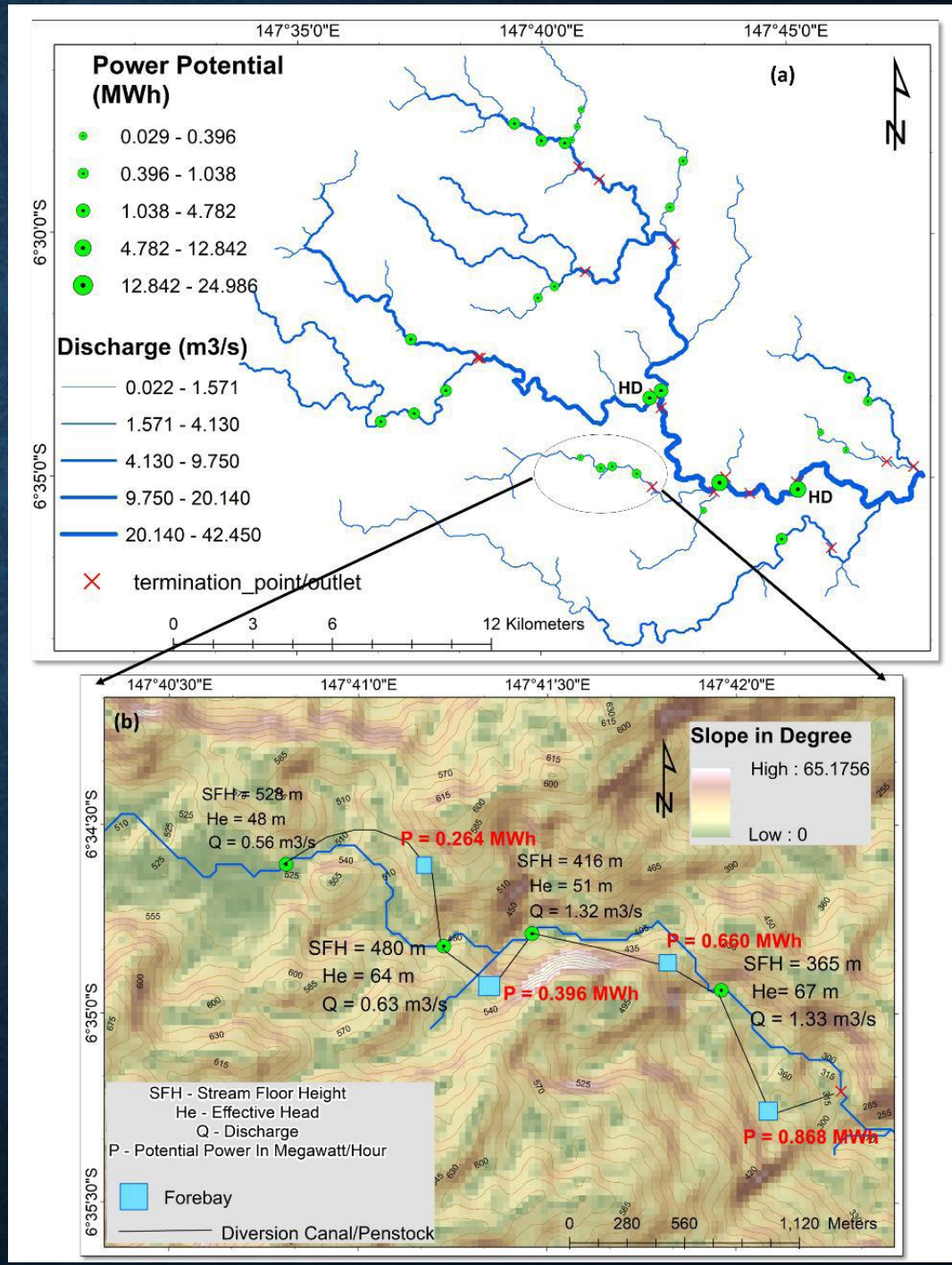
Application : Flooding And Erosion



Source: T. Sekac (2016)

Application – Renewable Energy Potential Mapping





Source: T. Sekac et al (2023)

References:

Jensen, John R., 2015- Introductory digital image processing : a remote sensing perspective / John R. Jensen, University of South Carolina.
pages cm. -- (Pearson series in geographic information science) 4th ed.

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