

# SATPALDA Imagery Users Guide



This guide introduces customer to the fundamentals of satellite imagery, its sources, applications, and processing, while highlighting SATPALDA's expertise in delivering high-resolution data and geospatial solutions. It is designed to help users make informed choices and unlock the full potential of Earth Observation data.

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# SATELLITE IMAGERY USERS GUIDE

## INTRODUCTION TO EARTH OBSERVATION (EO)

Satellite imagery, often referred to as **Earth Observation (EO) data**, has become one of the most powerful tools for understanding our planet. From monitoring climate change to tracking urban growth, satellites provide a unique perspective by capturing consistent, reliable, and large-scale information across space and time.

Traditionally, satellite imagery was used mainly for military and scientific purposes, but today it is widely accessible to governments, researchers, companies, and even individuals. Farmers use it to assess crop health, disaster managers rely on it for emergency response, and city planners use it to monitor infrastructure development.

What makes satellite imagery so valuable is its ability to:

- **Cover large areas** – satellites can capture entire regions or countries in a single image.
- **Observe change over time** – regular revisits allow us to monitor trends such as deforestation, melting glaciers, or urban expansion.
- **See beyond human vision** – satellites capture not only visible light but also infrared, radar, and other wavelengths, revealing information about vegetation, soil moisture, air quality, and more.
- **Support decision-making** – by turning raw images into insights, satellite data helps in planning, policy, business, and scientific research.

As technology advances, satellite imagery is becoming more detailed, more frequent, and easier to access. What was once limited to a handful of agencies is now available to anyone with an internet connection.

This guide is designed to help users – whether beginners or professionals – **understand, access, and make effective use of satellite imagery** for their specific needs.

👉 This guide by **SATPALDA** is designed to make satellite imagery **simple, practical, and client-focused**. It explains the basics, helps you compare sources, and shows how SATPALDA's expertise ensures you get the **right imagery, at the right time, for the right application**.

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 SATPALDA – Your Trusted Partner

With **over two decades of experience**, SATPALDA has been a trusted provider of **high-resolution satellite imagery, Digital Elevation Models (DEMs), and geospatial solutions** to government agencies, research institutions, private enterprises, and international organizations.

Our partnerships with leading satellite operators like **Maxar, Airbus, BlackSky, Synspective and others** allow us to offer customers:

- The **highest resolution imagery** available commercially (as fine as 15–30 cm).
  - Both **optical and radar (SAR)** data to ensure all-weather, day-and-night coverage.
  - Access to vast **satellite imagery archives** and **on-demand tasking services**.
  - **Customized solutions** including image processing, feature extraction, and analytics.
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## 🌟 What You Will Gain from This Guide

This SATPALDA Imagery Users Guide will help you:

- Understand the **basics of satellite imagery** (orbits, resolutions, sensors, formats).
- Learn about **different imagery sources** (public, commercial, and SATPALDA's offerings).
- Identify **key applications** relevant to your industry.
- Gain confidence in **choosing the right imagery** for your needs.

✅ By the end of this guide, you will be equipped to **make informed choices about satellite imagery** and understand how SATPALDA can be your geospatial partner in achieving data-driven outcomes.

## 1. RECENT DEVELOPMENTS IN SATELLITE IMAGERY

Over the past decade, satellite imagery has rapidly evolved from being a niche tool for governments and research institutions to a mainstream resource accessible to businesses, NGOs, and even individuals. Several key developments have shaped this transformation:

### 1.1. HIGHER SPATIAL RESOLUTION

- Commercial providers now offer imagery as fine as **15–30 cm per pixel**, allowing users to detect details like vehicles, small infrastructure, and crop health.
- In contrast, free imagery sources such as Landsat (30 m) and Sentinel-2 (10 m) still play a crucial role for large-scale monitoring and long-term environmental analysis.

### 1.2. IMPROVED REVISIT TIMES

- Instead of waiting weeks for new imagery, modern satellite constellations provide **daily or near-daily coverage**.
- Companies like Planet operate fleets of small satellites that scan the entire Earth's surface every day, enabling time-sensitive applications such as **disaster monitoring, agriculture forecasting, and urban expansion tracking**.

### 1.3. NEW BUSINESS MODELS

- **Subscription-based access** makes high-quality imagery more affordable and predictable in cost.
- **On-demand tasking** lets organizations request fresh imagery of a specific location within hours or days.
- **Open data initiatives** (e.g., NASA, ESA) continue to provide free access to valuable long-term archives.

### 1.4. ADVANCES IN TECHNOLOGY

- **Miniaturization of satellites** (CubeSats, nanosatellites) has drastically reduced launch costs, enabling larger constellations.
- **Cloud-based platforms** (e.g., Google Earth Engine, Sentinel Hub) now provide instant access, processing, and visualization of petabytes of data.
- **Artificial Intelligence (AI) and Machine Learning (ML)** integration allows automated detection of changes, objects, and patterns at scale.

### 1.5. GROWING ACCESSIBILITY

- Tools and platforms have become more **user-friendly**, removing barriers of technical expertise.
- Even organizations without GIS specialists can now subscribe to ready-to-use satellite insights for agriculture, forestry, climate monitoring, and infrastructure planning.

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**KEY TAKEAWAY:**

Satellite imagery is no longer restricted to scientists or governments. Thanks to **higher resolution, faster revisit times, flexible pricing, and cloud-based tools**, it has become a powerful decision-making asset across industries.

## 2. COMMERCIAL EXPANSION AND NEW OPPORTUNITIES IN SATELLITE IMAGERY

The satellite imagery industry has undergone **rapid transformation** in the past decade. What was once limited to a few government-backed missions is now a vibrant ecosystem of **public programs, commercial operators, and startups**, delivering imagery at unprecedented resolutions and speeds.

### 2.1 NEW PLAYERS IN THE MARKET

Traditionally, satellite imagery was dominated by agencies such as **NASA (USA), ESA (Europe), and ISRO (India)**. Today, dozens of **private companies and startups** have entered the field, offering specialized imagery solutions.

- **Planet Labs** – operates the world’s largest fleet of Earth-observing satellites (Doves), providing daily global coverage.
- **Satelloptic** – focuses on cost-efficient constellations for high-resolution imagery.
- **ICEYE & Capella Space** – pioneers in small-satellite **SAR (Synthetic Aperture Radar)**, enabling imaging through clouds and at night.
- **Axelspace, BlackSky, and others** – emerging players providing frequent revisit and targeted imagery.

This diversification means **more choice, faster access, and lower costs** for end users.

### 2.2 HIGH-RESOLUTION COMMERCIAL IMAGERY

- **Resolution has advanced dramatically** – from 10–30 meters (Landsat era) to sub-meter detail (Maxar’s WorldView-3 and WorldView-4 with ~30 cm resolution).
- Commercial providers now deliver imagery so detailed that **vehicles, roads, and even small field boundaries** are visible.
- This is especially valuable for applications such as **urban planning, defense intelligence, precision agriculture, and disaster response**.

In short: commercial imagery brings near **“drone-like” detail from space**, but at a global scale.

### 2.3 SUBSCRIPTION & OPEN-ACCESS MODELS

The way users **access imagery** has also changed:

- **Open-access platforms** (e.g., **Copernicus Sentinel, USGS Landsat**) provide **free global data**, often at 10–30 m resolution.
- **Subscription models** (e.g., Planet, Maxar etc) offer **higher-resolution imagery with flexible licensing**, catering to businesses and governments.
- **Hybrid models** now exist, where **basic data is free**, but advanced features (higher resolution, analytics, tasking) are paid.

This democratization means even small organizations and individuals can now **leverage satellite imagery without huge budgets**.

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☑ **KEY TAKEAWAY:**

The satellite imagery market is shifting from government-led missions to a dynamic mix of commercial and public sources, making imagery more affordable, accessible, and diverse in resolution and applications.

### 3. UNDERSTANDING SATELLITE ORBITS

Every Earth observation satellite follows a specific **orbit**—the path it takes around Earth. The choice of orbit determines what areas the satellite can see, how often it passes over them, and the type of applications it supports.

#### 3.1 LOW EARTH ORBIT (LEO)

- **Altitude:** ~200 km to 1,200 km above Earth
- **Coverage:** Small swath (narrow strip of Earth per pass)
- **Revisit Frequency:** High (satellites orbit Earth every ~90 minutes)
- **Use Cases:** High-resolution imaging, scientific missions, Earth monitoring
- **Examples:** Landsat, Sentinel-2, PlanetScope, WorldView series

👉 **Why important:** Ideal for **detailed imagery** and **frequent revisits**, but cannot cover the whole Earth at once.

#### 3.2 MEDIUM EARTH ORBIT (MEO)

- **Altitude:** ~2,000 km to 35,000 km
- **Coverage:** Larger area than LEO, but with lower spatial detail
- **Use Cases:** Navigation and positioning systems
- **Examples:** GPS (USA), Galileo (EU), GLONASS (Russia), IRNSS/NavIC (India)

👉 **Why important:** Not typically used for imagery, but **crucial for satellite navigation** that supports mapping and geospatial applications.

#### 3.3 GEOSTATIONARY ORBIT (GEO)

- **Altitude:** ~35,786 km above Earth's equator
- **Position:** Appears fixed over one location on Earth
- **Coverage:** Continuous observation of the same region
- **Use Cases:** Weather monitoring, communication, disaster tracking
- **Examples:** GOES (USA), INSAT (India), Himawari (Japan)

👉 **Why important:** Provides **real-time, constant monitoring**, but imagery resolution is lower due to the high altitude.

#### 3.4 SUN-SYNCHRONOUS ORBIT (SSO)

- A special type of LEO orbit
- Satellite passes over the same part of Earth at the **same local solar time each day**
- Ensures consistent **lighting conditions**, useful for comparing images over time
- **Examples:** Sentinel-2, Landsat-8/9, SPOT satellites

👉 **Why important:** Enables accurate **long-term monitoring of land, vegetation, and climate change.**

### 3.5 WHY ORBITS MATTER FOR APPLICATIONS

- **LEO** → High-detail mapping, agriculture, urban planning, defense
- **MEO** → Navigation, timing, positioning
- **GEO** → Weather, disaster alerts, continuous monitoring
- **SSO** → Environmental monitoring, land use, seasonal studies

#### ☑️ KEY TAKEAWAY:

The **orbit defines the satellite's strengths**—whether it provides detailed local images (LEO), continuous weather updates (GEO), or long-term consistent monitoring (SSO). Choosing the right orbit type is the **first step in selecting the right satellite data** for your project.

## 4. TEMPORAL RESOLUTION (REVISIT TIME)

**Temporal resolution** refers to how often a satellite captures imagery of the same location on Earth. This is also called **revisit time**. It determines whether you can observe **daily changes, seasonal patterns**, or only long-term shifts.

### 4.1 DEFINITION AND IMPORTANCE

- **Definition:** The frequency with which a satellite can image the same place on Earth.
- **High temporal resolution = Short revisit time** (daily or multiple times per day).
- **Low temporal resolution = Long revisit time** (weeks or months).

👉 **Why it matters:** Some projects (like crop health monitoring or flood mapping) need **daily updates**, while others (like geological studies) may only need data every few months.

### 4.2 EXAMPLES OF REVISIT TIMES

- **Daily:**
  - PlanetScope (Planet Labs) – covers the whole Earth daily.
  - Sentinel-2 (constellation of 2 satellites) – ~5-day revisit at the equator.
- **Weekly:**
  - Landsat 8/9 – 16-day cycle, but combined gives ~8-day revisit.
- **Seasonal / Annual:**
  - Some radar missions (older satellites) may only revisit areas once every several weeks.

### 4.3 APPLICATIONS BASED ON REVISIT NEEDS

- **Daily revisit:**
  - Agriculture (crop monitoring, precision farming)
  - Disaster response (floods, wildfires, hurricanes)
  - Defense and intelligence (surveillance, border monitoring)
- **Weekly revisit:**
  - Urban growth studies
  - Water body monitoring
  - Forestry management
- **Seasonal / Annual revisit:**

- Climate change tracking
- Glacier and ice sheet monitoring
- Geological mapping

#### ☑ Key Takeaway:

Temporal resolution = “How often can I look at the same place?”

Projects that require timely decision-making (like disasters or farming) need high temporal resolution, while long-term studies can rely on lower frequencies.

## 5. SPATIAL RESOLUTION (IMAGE DETAIL)

**Spatial resolution** describes the amount of detail visible in a satellite image. It is usually defined by the **size of one pixel on the ground** (called **Ground Sample Distance – GSD**). The smaller the pixel, the more detailed the imagery.

### 5.1 PIXEL SIZE EXPLAINED

- **Pixel:** The smallest unit of a digital image.
- **Example:** A 10 m resolution pixel means each pixel represents a **10 × 10 meter** area on the ground.
- **Smaller pixel size = finer detail**, but also larger file sizes.

### 5.2 CATEGORIES OF RESOLUTION

- **Low Resolution (250 m – 1 km):**
  - Coarse detail, suitable for global or regional studies.
  - **Examples:** MODIS (250–1,000 m), NOAA AVHRR (~1 km).
  - **Applications:** Climate, weather, vegetation monitoring at continental scale.
- **Medium Resolution (10 – 30 m):**
  - Balanced detail, free data available.
  - **Examples:** Sentinel-2 (10 m), Landsat (30 m).
  - **Applications:** Land use/land cover mapping, agriculture, water bodies, forestry.
- **High Resolution (1 – 5 m):**
  - Detailed enough for city blocks, fields, and infrastructure.
  - **Examples:** SPOT (1.5 m), RapidEye (5 m).
  - **Applications:** Urban planning, precision agriculture, infrastructure mapping.
- **Very High Resolution (30 cm – 1 m):**
  - Near “drone-like” detail from space.
  - **Examples:** Maxar’s WorldView-3 (31 cm), Pleiades Neo (30 cm).
  - **Applications:** Defense, disaster response, detailed asset monitoring, cadastral mapping.

### 5.3 MATCHING RESOLUTION TO PROJECT NEEDS

- **Regional / national studies** → Low to medium resolution (free sources often sufficient).
- **Urban planning, agriculture** → High resolution (~1–5 m).
- **Defense, infrastructure, disaster relief** → Very high resolution (sub-meter).

👉 **Rule of thumb:** Use the **lowest resolution that still meets your needs**—it saves cost, storage, and processing time.

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☑ **KEY TAKEAWAY:**

**Spatial resolution = “How much detail can I see?”**

From coarse climate models (1 km) to spotting cars and roads (30 cm), choosing the right resolution ensures you balance **cost, detail, and practicality**.

## 6. PANCHROMATIC VS. MULTISPECTRAL IMAGERY

Satellite sensors capture data in different ways depending on their **spectral bands** (parts of the electromagnetic spectrum). Two common types are **panchromatic** and **multispectral** imagery.

### 6.1 PANCHROMATIC IMAGERY

- **What it is:** A single-band, grayscale image capturing **all visible light (and sometimes near-infrared) in one broad band**.
- **Resolution:** Often has the **highest spatial resolution** on a satellite.
- **Appearance:** Black-and-white but with very fine detail.
- **Examples:** WorldView-3 Panchromatic (31 cm), SPOT Panchromatic.
- **Use Cases:**
  - Urban mapping (roads, buildings, infrastructure)
  - Object detection (vehicles, ships, runways)
  - Base maps where fine detail is more important than color

👉 Think of it as a **high-detail black-and-white photo** from space.

### 6.2 MULTISPECTRAL IMAGERY

- **What it is:** Captures multiple **narrower bands** of light (visible + near-infrared + shortwave infrared).
- **Resolution:** Usually lower than panchromatic, but provides **richer information**.
- **Appearance:** Can be displayed in **true color** (like a photo) or **false color** (to highlight vegetation, water, soil, etc.).
- **Examples:** Sentinel-2 (13 bands, 10–60 m), Landsat-9 (11 bands, 30 m), WorldView-3 (16 bands).
- **Use Cases:**
  - Agriculture (crop health, NDVI vegetation indices)
  - Water quality and hydrology studies
  - Land cover classification
  - Forest and soil mapping

👉 Think of it as a **colored, information-rich image** with insights beyond what the human eye can see.

### 6.3 COMPLEMENTARY USE

- Many satellites collect **both panchromatic and multispectral data**.
- By combining them, analysts can get both **high spatial detail** and **spectral richness**.
- This leads directly to the concept of **pansharpener** (explained later).

☑ **Key Takeaway:**

- **Panchromatic = sharp detail, grayscale**
- **Multispectral = color + rich analysis**
- Both are often combined to produce imagery that is **both detailed and informative**.

## 7. SATELLITE SENSORS

A **satellite sensor** is the instrument on board that collects data about Earth. Sensors can be grouped into two main categories: **passive** (they record natural energy, usually sunlight reflected from Earth) and **active** (they send out their own signal and measure what bounces back).

### 7.1 PASSIVE SENSORS

- **How they work:** Detect natural energy reflected or emitted by Earth (mainly sunlight during the day, thermal radiation at night).
- **Types:**
  - **Optical sensors** → Capture visible and near-infrared light (like a camera).
  - **Thermal/Infrared sensors** → Detect heat radiation emitted by objects.
- **Examples:** Landsat, Sentinel-2, MODIS.
- **Limitations:** Cannot see through **clouds** and have limited capability at night (except for thermal).
- **Applications:**
  - Land use/land cover mapping
  - Vegetation indices (NDVI, crop health)
  - Thermal mapping (urban heat, forest fires)

### 7.2 ACTIVE SENSORS

- **How they work:** Emit their own energy (radio waves or laser pulses) and record the reflection from Earth's surface.
- **Types:**
  - **Radar (SAR – Synthetic Aperture Radar):** Uses microwave signals, can penetrate clouds and work day & night.
  - **LiDAR (Light Detection and Ranging):** Uses laser pulses, excellent for 3D terrain models and vegetation structure.
- **Examples:**
  - Radar → Sentinel-1 (C-band SAR), ICEYE, Capella Space.
  - LiDAR → ICESat-2, GEDI (on ISS).
- **Advantages:**
  - All-weather capability (radar sees through clouds, fog, smoke).
  - Night imaging (since they generate their own signal).
- **Applications:**
  - Flood monitoring (SAR penetrates clouds/rain).
  - Glacier and ice studies.
  - 3D mapping of terrain and forests (LiDAR).
  - Infrastructure monitoring (subsidence, landslides).

### 7.3 CLOUD PENETRATION & NIGHT IMAGING

- **Optical sensors** → limited in cloudy regions (like tropics, monsoons).
- **Radar (SAR)** → ideal for cloud-heavy or night conditions (disaster monitoring, military surveillance).
- **LiDAR** → excellent for precise elevation, vegetation canopy, but limited in area coverage compared to radar.

#### ✓ Key Takeaway:

- **Passive sensors** = sunlight or heat-based (great for daytime, limited by clouds).

- **Active sensors** = radar & LiDAR (all-weather, day/night, detailed elevation/structure). Choosing the right sensor depends on whether you need **color/detail** (optical), **all-weather monitoring** (SAR), or **3D mapping** (LiDAR).

## 8. ATMOSPHERIC CORRECTION

When a satellite sensor captures an image, the signal has to travel through the **Earth's atmosphere** before reaching the sensor. Along the way, particles, gases, and water vapor can **distort or scatter the light**, leading to errors in the data.

**Atmospheric correction** is the process of removing or minimizing these effects so that the imagery truly represents the Earth's surface.

### 8.1 WHY CORRECTIONS ARE NEEDED

- **Scattering:** Dust, haze, and aerosols scatter sunlight, making surfaces appear brighter or washed out.
- **Absorption:** Water vapor, carbon dioxide, and ozone absorb parts of the spectrum, reducing signal strength.
- **Variability:** Weather and atmospheric conditions vary daily, making it hard to compare images over time without correction.

👉 Without correction, results like **NDVI vegetation indices or land cover classification** can be misleading.

### 8.2 COMMON CORRECTION METHODS

- **Dark Object Subtraction (DOS):** Assumes some pixels should be completely dark (like deep water) and adjusts accordingly.
- **Radiometric Calibration:** Converts raw digital numbers to reflectance values using sensor-specific calibration data.
- **Topographic Correction:** Adjusts for terrain effects (shadows, slopes) in mountainous areas.
- **Atmospheric Models:** Tools like **FLAASH, 6S, Sen2Cor** simulate atmospheric effects and correct them.

### 8.3 PROVIDERS VS. USER-LEVEL CORRECTION

- **Providers:** Many satellites (like Sentinel-2, Landsat) now offer **Level-2A products**, which are already atmospherically corrected.
- **Users:** In some cases (especially research), users perform **custom correction** for more accurate results.
  - Example: Agricultural researchers may apply specialized correction for precise crop health monitoring.

#### ✅ Key Takeaway:

Atmospheric correction ensures that satellite images reflect **true ground conditions**, not distorted values caused by haze, dust, or clouds. For most practical applications, **pre-corrected imagery from providers** is sufficient, but advanced users may apply their own corrections for scientific accuracy.

## 9. PANSHARPENING

Satellites often capture two main types of images:

- **Panchromatic (Pan):** High-resolution, grayscale.
- **Multispectral (MS):** Lower-resolution, multi-band (color + beyond visible spectrum).

**Pansharpening** is the process of **fusing these two types of images** to create a single product that combines the **spatial detail of panchromatic imagery** with the **spectral richness of multispectral imagery**.

### 9.1 WHAT IT IS AND WHY IT'S USED

- **Pan alone:** Very sharp, but no color information.
- **MS alone:** Rich spectral info (colors, vegetation indices), but coarser detail.
- **Pansharpened image:** High detail **and** accurate colors → the best of both worlds.

👉 Example: A 30 cm Pan + 1.2 m MS image can be fused into a **30 cm multispectral image**.

### 9.2 BENEFITS FOR ANALYSIS

- **Improved visual quality:** More realistic and detailed maps.
- **Better classification accuracy:** Land use/land cover mapping benefits from both detail and spectral info.
- **Enhanced feature detection:** Roads, buildings, water bodies, and crop patterns become clearer.

### 9.3 LIMITATIONS TO CONSIDER

- **Spectral distortion:** Some pansharpening methods slightly alter the color values, affecting scientific accuracy.
- **Processing cost:** Requires extra computational resources.
- **Data availability:** Not all satellites provide both Pan and MS bands (though most high-resolution ones do).

👉 For precise scientific measurements (like reflectance analysis), raw multispectral images may still be preferred.

#### ✅ Key Takeaway:

Pansharpening creates imagery that is **both sharp and information-rich**, making it extremely useful for **urban planning, defense, and visualization**. However, for **scientific research**, raw multispectral data may be more reliable.

## 10. ORTHORECTIFICATION

Raw satellite images are not perfectly aligned with Earth's true surface. Factors like the **satellite's viewing angle, terrain elevation, and sensor distortions** can cause features to appear **shifted, stretched, or tilted**.

**Orthorectification** is the process of correcting these distortions so that the image has a **uniform scale** and matches the true geographic coordinates of Earth.

## 10.1 REMOVING DISTORTIONS

- **Geometric distortions:** Caused by the sensor’s angle and satellite movement.
- **Terrain distortions:** Hills, valleys, and slopes cause displacement in raw images.
- **Relief displacement:** Tall buildings may appear “leaning” away from the center of the image.

Orthorectification uses **Digital Elevation Models (DEMs)** and sensor metadata to correct these issues.

## 10.2 CREATING ACCURATE BASE MAPS

- Orthorectified images can be aligned precisely with **maps, GIS layers, and survey data**.
- Every pixel in the image is assigned a **geographic coordinate (latitude/longitude or UTM)**.
- This makes it possible to overlay satellite data with **roads, boundaries, and ground surveys**.

## 10.3 IMPORTANCE FOR GIS PROJECTS

- **Urban planning:** Accurate building footprints, roads, and utility layouts.
- **Infrastructure monitoring:** Roads, bridges, pipelines need exact alignment.
- **Disaster management:** Flood extents and fire boundaries must match ground coordinates.
- **Legal & cadastral mapping:** Property boundaries require **precise geolocation**.

👉 Without orthorectification, images may look sharp but will not line up with maps or GPS coordinates.

### ✅ Key Takeaway:

Orthorectification makes satellite imagery **geometrically accurate**, turning raw images into reliable **map-ready datasets**. For any GIS or decision-making project, orthorectified imagery is essential.

## 11. IMAGE ARCHIVES

One of the biggest advantages of satellite imagery is the existence of **decades-long archives**. These repositories provide access to historical images that enable users to study **changes over time**—from urban growth to deforestation and climate impacts.

### 11.1 PUBLIC ARCHIVES

- **Landsat Program (USGS/NASA):**
  - Continuous record since **1972**.
  - Resolution: 30 m (multispectral).
  - Free and open access.
  - **Use Cases:** Land cover change, forest monitoring, urban expansion, climate studies.
- **Copernicus Sentinel (ESA):**
  - Sentinel-1 (radar, since 2014), Sentinel-2 (optical, since 2015).
  - Resolution: 10–20 m.
  - Free and open access via **Copernicus Open Access Hub, Sentinel Hub**.
  - **Use Cases:** Agriculture, flood mapping, environmental monitoring.

👉 These archives provide **open, global coverage** that supports research, policymaking, and sustainable development.

### 11.2 COMMERCIAL ARCHIVES

- **Maxar (DigitalGlobe legacy):**
  - Archive of very high-resolution imagery (QuickBird, IKONOS, GeoEye, WorldView).
  - Coverage since early 2000s, resolution down to 30 cm.
  - **Use Cases:** Defense, disaster response, infrastructure monitoring.
- **Airbus (SPOT, Pleiades, Pleiades Neo):**
  - Archive going back to 1986 (SPOT).
  - High-resolution optical and stereo data.
  - **Use Cases:** Environmental monitoring, 3D terrain models, city planning.
- **Planet Labs:**
  - Daily archive from ~2016 onwards, medium to high resolution (3–5 m).
  - **Use Cases:** Agriculture, commodity monitoring, near-real-time analytics.

### 11.3 LONG-TERM MONITORING

- **Environmental Change:** Forest loss, glacier retreat, desertification.
- **Urban Growth:** Tracking city expansion over decades.
- **Disaster Comparison:** Pre- and post-event analysis (floods, earthquakes, wildfires).
- **Policy Support:** Governments use archives for climate reports and land-use planning.

#### ✓ Key Takeaway:

Image archives are **time machines from space**—they let us look back over decades to understand **how Earth has changed** and to build predictive models for the future.

## 12. SATELLITE TASKING (ON-DEMAND IMAGERY)

While archives are valuable for studying the past, sometimes users need **fresh, up-to-date images** of a specific location and time. This is where **satellite tasking** comes in.

### 12.1 WHAT IS SATELLITE TASKING?

- **Tasking** means **instructing a satellite to capture a new image** of a user-defined area.
- Users specify:
  - **Area of Interest (AOI)**
  - **Timeframe** (e.g., within the next few days)
  - **Resolution and bands required**
- Once tasked, the satellite adjusts its schedule to capture the imagery.

### 12.2 USE CASES

- **Disaster Monitoring**
  - Earthquakes, floods, wildfires → quick capture of affected regions.
- **Agriculture**
  - Crop monitoring during a specific growth stage.
- **Defense & Security**
  - Border monitoring, troop movements, conflict zones.
- **Infrastructure Projects**
  - Construction progress tracking, pipeline route checks.

### 12.3 COST AND LEAD TIME CONSIDERATIONS

- **Cost:** Tasking is usually more expensive than archived data, as it requires new collection.
- **Lead Time:**
  - Can range from **hours to a few days**, depending on cloud cover, orbit, and satellite availability.
  - Priority or emergency tasking is available at higher cost.
- **Licensing:** Commercial providers may restrict redistribution of tasked imagery.

✔ **Key Takeaway:**

Satellite tasking gives users **control over when and where imagery is collected**, making it essential for time-critical applications such as disaster response, defense, and precision agriculture.

## 13. MACHINE LEARNING & AI IN IMAGERY

The explosion of satellite imagery in recent years has made manual interpretation impractical. **Machine Learning (ML) and Artificial Intelligence (AI)** are now key to analyzing massive datasets quickly and accurately.

### 13.1 PATTERN RECOGNITION AND CHANGE DETECTION

- **Object detection:** Identify features like buildings, vehicles, ships, or trees.
- **Land cover classification:** Distinguish forests, urban areas, croplands, and water bodies.
- **Change detection:** Spot deforestation, urban growth, glacier retreat, or flood impacts by comparing imagery over time.

### 13.2 TRAINING DATASETS AND AUTOMATION

- **Supervised learning:** Models are trained using labeled examples (e.g., images tagged as “forest” vs. “urban”).
- **Unsupervised learning:** Algorithms cluster pixels into categories without prior labeling.
- **Automation:** Once trained, AI models can process **thousands of images per day**, flagging areas of interest for human review.

### 13.3 REAL-WORLD APPLICATIONS

- **Agriculture:** Crop yield estimation, pest/disease detection.
- **Disaster Management:** Automated flood mapping and damage assessment.
- **Environmental Monitoring:** Detecting illegal mining, deforestation, and pollution.
- **Urban Planning:** Identifying informal settlements, road expansion, and land use trends.
- **Defense & Intelligence:** Monitoring troop movement, missile sites, or naval activities.

✔ **Key Takeaway:**

AI and ML transform raw imagery into **actionable insights**, enabling faster, scalable, and more accurate decision-making across industries.

## 14. USING SATELLITE IMAGERY IN GIS

Satellite imagery becomes far more powerful when combined with **Geographic Information Systems (GIS)**. GIS allows users to **store, analyze, and visualize** imagery alongside other spatial data, making it central to applied geospatial projects.

### 14.1 INTEGRATION WITH GIS PLATFORMS

- **ArcGIS (Esri):** Industry-standard commercial GIS with strong remote sensing tools.
- **QGIS:** Free and open-source GIS with plugins for satellite imagery.
- **Other platforms:** Google Earth Pro, GRASS GIS, ERDAS IMAGINE (for advanced image analysis).

## 14.2 FREE VS. COMMERCIAL TOOLS

- **Free Tools (QGIS, Google Earth Engine):** Great for research, NGOs, and small projects.
- **Commercial Tools (ArcGIS, ERDAS):** Offer better automation, cloud integration, and enterprise support, but come at higher costs.

## 14.3 EXAMPLES OF GIS + IMAGERY WORKFLOWS

1. **Disaster Response:**
  - Import new satellite images into GIS.
  - Overlay with population data to map affected areas.
2. **Agriculture Monitoring:**
  - Combine NDVI (vegetation index) maps with soil data.
  - Identify low-yield zones for targeted intervention.
3. **Urban Planning:**
  - Use imagery to map urban expansion.
  - Integrate road networks and zoning data for planning decisions.
4. **Hydrology & Water Resources:**
  - Combine imagery with DEM/DTM layers.
  - Analyze watershed changes, flooding risk, or reservoir status.

### ✓ Key Takeaway:

GIS turns satellite imagery into a **decision-support tool**, allowing users to overlay, analyze, and extract meaningful insights for real-world applications.

## 15. PRACTICAL CONSIDERATIONS FOR USERS

Before adopting satellite imagery for any project, users must balance **technical needs, budget, and operational constraints**.

### 15.1 COST VS. RESOLUTION TRADE-OFFS

- **High-resolution imagery (30–50 cm):** Very detailed but costly. Best for urban planning, defense, and infrastructure monitoring.
- **Medium-resolution imagery (5–10 m):** Cheaper, suitable for agriculture, forestry, and environmental studies.
- **Free imagery (10–30 m, e.g., Sentinel, Landsat):** Ideal for research, large-area monitoring, and NGOs.

👉 The **higher the resolution**, the higher the cost and storage requirement.

### 15.2 LICENSING AND USAGE RIGHTS

- **Free/Open Data (Sentinel, Landsat):** Available for anyone with no restrictions.
- **Commercial Imagery (Maxar, Airbus, Planet):** Comes with licenses. Restrictions may apply on sharing, redistribution, or publication.
- **Tip:** Always check the **End User License Agreement (EULA)** before using imagery in reports or public platforms.

### 15.3 FILE SIZES AND STORAGE MANAGEMENT

- Satellite images can be very large:
  - A single high-resolution scene can exceed **1–5 GB**.
  - Archives for long-term projects can quickly grow into **terabytes**.
- Users must plan for:
  - **Efficient storage (cloud or local servers)**.
  - **Data compression (GeoTIFF, JPEG2000)**.
  - **High-speed internet** for downloading large datasets.

#### ✓ Key Takeaway:

Success with satellite imagery depends not only on selecting the **right data** but also on **managing cost, licensing, and storage** efficiently.

## 16. FREE SATELLITE IMAGERY SOURCES

Many organizations provide **open-access satellite imagery** at no cost. These datasets are widely used in **research, education, environmental monitoring, and development projects**.

### 16.1 USGS EARTH EXPLORER

- **Imagery Available:** Landsat, MODIS, ASTER, and more.
- **Resolution:** 15–30 m (Landsat), 250 m–1 km (MODIS).
- **Strengths:**
  - Long historical archive (since 1972 for Landsat).
  - Excellent for **time-series analysis** and long-term monitoring.
- **Access:** earthexplorer.usgs.gov.

### 16.2 COPERNICUS OPEN ACCESS HUB

- **Imagery Available:** Sentinel-1 (Radar), Sentinel-2 (Optical), Sentinel-3 & 5P (Atmospheric & Ocean monitoring).
- **Resolution:** 10–60 m (Sentinel-2 optical), radar data from Sentinel-1.
- **Strengths:**
  - **High revisit time** (2–5 days).
  - Great for agriculture, forestry, flood monitoring.
- **Access:** scihub.copernicus.eu.

### 16.3 GOOGLE EARTH ENGINE (GEE) / GOOGLE EARTH PRO

- **Imagery Available:** Landsat, Sentinel, MODIS, plus commercial datasets for visualization.
- **Strengths:**
  - **Cloud-based processing** — no need to download large files.
  - Built-in machine learning and big data analysis tools.
  - **Google Earth Pro** offers free visualization of global high-resolution imagery (but limited analysis).
- **Access:** earthengine.google.com.

#### ✓ Key Takeaway:

Free imagery is powerful for most **scientific and developmental projects**. While not as detailed as commercial sources, it offers excellent coverage, open access, and strong community support.

## 17. COMMERCIAL SATELLITE IMAGERY PROVIDERS

Commercial providers offer **high-resolution, on-demand satellite imagery** that goes beyond what free/open sources can deliver. These datasets are critical for **defense, infrastructure, disaster response, urban planning, and precision agriculture**.

### 17.1 MAJOR GLOBAL PROVIDERS

1. **Maxar Technologies (USA)**
  - **Satellites:** WorldView series, GeoEye-1.
  - **Resolution:** Up to **30 cm**.
  - **Revisit:** Multiple times daily.
  - **Strengths:** Widest archive, defense-grade data.
2. **Airbus Defence & Space (Europe)**
  - **Satellites:** Pléiades, SPOT, Vision-1.
  - **Resolution:** 30 cm (Pléiades Neo).
  - **Strengths:** Large swath width, useful for regional mapping.
3. **Planet Labs (USA)**
  - **Satellites:** Dove (CubeSats), SkySat.
  - **Resolution:** 50 cm (SkySat), 3–5 m (Dove).
  - **Strengths:** **Daily revisit**, best for agriculture, environment.
4. **SI Imaging Services (South Korea)**
  - **Satellites:** KOMPSAT series.
  - **Resolution:** 40 cm to 4 m.
  - **Strengths:** Flexible tasking, high-quality optical and radar data.
5. **Other Emerging Providers**
  - BlackSky, Satellogic, Axelspace, ICEYE (radar), offering frequent revisit and niche solutions.

### 17.2 SATPALDA – YOUR TRUSTED SOURCE IN INDIA

SATPALDA is a leading **Indian geospatial service provider** and **authorized reseller of commercial satellite imagery**.

- **Partnerships with Global Operators:** SATPALDA delivers data from **Maxar, AxelGlobe, BlackSky, Synspec** and more.
- **Resolution Options:** From **30 cm ultra-high resolution** to **low/medium resolution** for large-area monitoring.
- **Revisit:** Daily to weekly, depending on satellite.
- **Coverage:** Worldwide, with focus on **India and Asia-Pacific projects**.
- **Services Beyond Imagery:**
  - DSM, DTM, and DEM generation.
  - Orthorectification & mosaicking.
  - Pansharpener & atmospheric correction.
  - GIS-ready products for urban planning, forestry, agriculture, hydrology, and disaster management.

#### ✓ Key Takeaway:

Commercial providers deliver **precision and timeliness** unmatched by free sources. With SATPALDA as a trusted partner, clients can access **multi-provider datasets** tailored to project needs — whether for **urban infrastructure, agriculture, or defense-grade applications**.

## 18. ABOUT THIS GUIDE

### 18.1 PURPOSE OF THE GUIDE

This guide was created to serve as a **comprehensive, practical resource** for anyone looking to understand and make use of satellite imagery. From the fundamentals of orbits and resolution to advanced topics like machine learning and tasking, it brings together the essential knowledge that users need to make informed decisions.

### 18.2 WHO CAN BENEFIT FROM IT

- **Government agencies** – for urban planning, infrastructure monitoring, natural resource management.
- **Researchers & academicians** – for environmental studies, disaster monitoring, climate change analysis.
- **Private companies** – in agriculture, construction, energy, and logistics requiring up-to-date imagery.
- **GIS professionals & students** – as a reference for integrating imagery into spatial analysis projects.
- **Defense & security organizations** – needing reliable, high-resolution, timely imagery.

### 18.3 SUGGESTED NEXT STEPS FOR USERS

1. **Define your project need** – resolution, revisit, and budget.
2. **Explore free sources first** – like Landsat, Sentinel, and Google Earth Engine for feasibility studies.
3. **Consider commercial providers** – when higher precision, frequent updates, or guaranteed tasking are required.
4. **Leverage expert partners like SATPALDA** – for sourcing imagery, preprocessing, and GIS-ready solutions.
5. **Stay updated** – as new satellites, AI methods, and open-data policies continue to transform the field.

#### ✓ Key Takeaway:

This guide is not just theoretical — it is meant as a **decision-making tool**. With providers like **SATPALDA**, users can turn knowledge into action and make satellite imagery a practical part of their projects.

## 19. APPENDIX: COMMERCIAL SATELLITE IMAGERY PROVIDERS (COMPARISON TABLE)

Provider	Public/Private	Max Resolution	Typical Revisit	Spectral Bands / Sensors	Notes / Access via SATPALDA
Maxar (USA)	Private	0.30 m (WorldView-3)	<1 day	Panchromatic, 8-band MS, SWIR	Largest archive, defense-grade; SATPALDA partner
Airbus Defence & Space (EU)	Private	0.30 m (Pléiades Neo/Pléiades)	Daily (tasking)	Optical (Panchro + MS), Radar (TerraSAR-X)	Strong in Europe/Asia; SATPALDA partner
Planet Labs (USA)	Private	0.5 m (SkySat), 3–5 m (PlanetScope)	Daily	4–8 band MS	Known for <b>daily Earth imaging</b> ; SATPALDA partner
SI Imaging Services (Korea)	Private	0.40–0.5 m (KOMPSAT-3/3A)	1–3 days	Panchro + MS	Affordable optical & radar; SATPALDA partner

BlackSky (USA)	Private	0.9 m	Up to 15 revisits/day	Panchro + MS	Real-time monitoring for defense/logistics; SATPALDA partner
Satelloptic (Argentina)	Private	0.7 m	Weekly–daily (expanding fleet)	4-band MS, hyperspectral R&D	Low-cost large-area coverage
ICEYE (Finland)	Private	0.25–1 m (SAR)	Multiple times/day	Synthetic Aperture Radar (X-band)	Night & all-weather imaging
Capella Space (USA)	Private	0.5 m (SAR)	4–6 revisits/day	SAR (high-res)	Disaster response, surveillance
Umbra (USA)	Private	0.15 m (SAR)	Sub-daily	SAR only	Highest-res commercial radar currently
Synspective (Japan)	Private	1 m (SAR)	1–2 days	SAR	Urban change detection, disaster management; SATPALDA partner

👉 **SATPALDA Advantage:** Clients don’t need to choose alone — we **evaluate requirements and recommend the best-fit source.**

✅ **How SATPALDA Fits In**

SATPALDA provides **multi-provider access** to the above satellites, offering:

- **Resolutions:** 30 cm to 5 m optical, 0.15–1 m SAR.
- **Revisit:** Daily to sub-daily (depending on constellation).
- **Products:** Standard imagery, DEM/DTM/DSM, orthorectified maps, GIS-ready datasets.
- **Value-add:** Preprocessing (pansharpening, correction), analytics, and integration with client workflow

**Contact Information**

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