

Empowering water utilities: Crafting an end-user-friendly reliability ranking for evaluating satellite remote sensing advances

Timothy Malthus, Filippo Nelli, Negar Taherishtiani, Peter Vanrolleghem, Nicolas Crosbie, Arash Zamyadi

Introduction

Satellite remote sensing provides extensive data for water management, enabling the measurement of hydro-meteorological and environmental variables. It aids in assessing trends, and hydrological conditions and guiding appropriate management actions. Satellite remote sensing serves as a cost-effective supplement to ground-based monitoring infrastructure. Over the past decade, satellite Earth observation technologies have advanced significantly, offering new opportunities for water utilities and agencies. These developments include improved satellite capabilities, enhanced data access, private sector involvement, and advancements in data processing and analytics. However, an end-user-friendly reliability ranking tool for evaluating numerous satellite remote sensing options is needed for operational decision making purposes.

Objectives

- Provide a state-of-the-art summary of recent operational trends and literature in satellite remote sensing to evaluate the existing capabilities and operationally available tools.
- Produce an end-user-friendly reliability ranking for evaluating satellite remote sensing advances through literature insights, as they may impact the functions of water utilities and agencies.

Methodology

Reviewed the choice of the right sensor

- **Spectral resolution:** the portion of the electromagnetic spectrum being measured by the sensor, often determined by the number of spectral bands, their locations, and their bandwidths. Generally, higher spectral resolution is achieved with narrower bandwidths and a greater number of spectral bands.
- **Spatial resolution:** The GSD, which is commonly expressed as the size of a single pixel in an image. A smaller GSD implies higher spatial resolution.
- **Temporal resolution:** Often given as the repeat coverage (or revisit) time.
- **Radiometric resolution:** The dynamic range of radiances measured and the ability of the sensor to measure changes in radiance, determined by the number of bits used across the dynamic range of radiances.

Reviewed fundamental characteristics of operational satellite optical sensors

Mission platform	Sensor	Spatial resolution (m)	Launch date	End date	Revisit time (days)	Data accessibility	Operational research
Landsat 5	TM	30	July 1982	June 2013	16	Open	Legacy
Landsat 7	ETM	30	April 1999	Still ongoing	16	Open	Legacy
Landsat 8	OLI	30	February 2013	May 2023	16	Open	Operational
Landsat 9	OLI	30	September 2021	Ongoing	16	Open	Operational
Sentinel 2A	MSI	10-60	June 2015	Ongoing	10	Open	Operational
Sentinel 2B	MSI	10-60	March 2017	Ongoing	10	Open	Operational
RapidEye	MSI	5	August 2008	April 2020	1	Commercial	Legacy
Planet Labs	DOVE	3.7	June 2014	Ongoing	<1	Commercial	Operational
	SkySAT	2 (0.9 pan)	November 2013	Ongoing	1	Commercial	Operational
Maxar	WorldView 2	1.85 (0.46 pan)	October 2009	Ongoing	>1.1	Commercial	Operational
	WorldView 3	1.24 (0.31 pan)	August 2013	Ongoing	<1	Commercial	Operational
	WorldView 4	1.25 (0.31 pan)	November 2016	Ongoing	1	Commercial	Operational
Sentinel 3A	OLCI	300	2016	Ongoing	1-2	Open	Operational
Sentinel 3B	OLCI	300	2017	Ongoing	1-2	Open	Operational
Suomi NPP	VIIRS	740	October 2011	Ongoing	0.5	Open	Operational
Aqua and Terra	MODIS	250-1000	1999/2002	Ongoing	1	Open	Operational

Focusing on four areas of application:



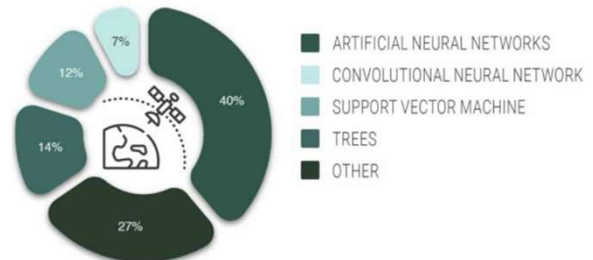
Results and Discussion

Developed a novel end-user-friendly reliability ranking for evaluating satellite remote sensing.

- Assessment of satellite optical sensors potential application to water-related implementations (1: highly suitable; 2: suitable; 3: potentially suitable; 4: not suitable)

Platform (Sensor)	Catchment Monitoring	Water Demand	Flood Monitoring	Water Quality	Farm Dam	Urban Areas	Drought Monitoring	Fire Spotting	Post Fire Impacts
Landsat 5 (TM)	1	1	2	2	2	1	1	1	1
Landsat 7 (ETM)	1	1	2	2	2	1	1	1	1
Landsat 8 (OLI)	1	1	2	2	2	1	1	1	1
Landsat 9 (OLI)	1	1	2	2	2	1	1	1	1
Sentinel 2A (MSI)	1	1	1	1	2	1	1	4	1
Sentinel 2B (MSI)	1	1	1	1	2	1	1	4	1
RapidEye (MSI)	1	1	1	1	1	1	1	4	1
PlanetScop (DOVE)	1	1	1	2	1	1	1	4	1
PlanetScop (SkySAT)	1	1	1	2	1	1	1	4	1
Maxar (WorldView 2)	1	1	1	2	1	1	1	4	1
Maxar (WorldView 3)	1	1	1	1	1	1	1	4	1
Maxar (WorldView 4)	1	1	1	2	1	1	1	4	1
Sentinel 3A (OLCI)	2	2	2	1	4	2	1	1	1
Sentinel 3B (OLCI)	2	2	2	1	4	2	1	1	1
Suomi NPP (VIIRS)	2	2	2	1	4	2	1	1	1
Aqua and Terra (MODIS)	2	2	2	1	4	2	1	1	1

- Explored the role of machine learning in enhancing water-related applications of satellite remote sensing



To learn more:

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