Can I Use Remote Sensing for My Mapping or Monitoring Application?

Underlying question for this section:
Is there a body of evidence to demonstrate that the use of remote sensing for mapping and monitoring a particular environmental variable is "operational"?

In this context, "operational" refers to an application based on commercially or freely available image data and software being used in a procedure that has been clearly documented and demonstrated through peer-review publication to be accurate within a specific environment.

The terms "operational", "feasible" and "not possible" have been used frequently in literature that has assessed remote sensing's suitability for monitoring specific environmental indicators. We have identified "operational" and "feasible" applications to ensure full capabilities of remote sensing are considered. Operational applications are those that have been clearly demonstrated to work accurately from commercially available image data and standard image processing systems, and are delivering data at the required resolution. Feasible applications are those that have been shown to work with experimental image data sets or over limited areas with very small pixels or global scales with large pixels.

The table below summarises the operational status (column 2) of environmental variables for use with remotely sensed data. Modified from Phinn et al. (2005), Roelfsema and Phinn (2004 Seagrass conference Townsville), and (Mumby et al., 2004).

Environmental Variable	**Can remote sensing be used?**	**Environmental constraints on application (e.g depth, clarity)**	**Examples of sensors used in previous work (System available)**
Seagrass (Presence/ absence)	Operational for optical sensors (optically shallow water) Operational for active in water sensors (optically shallow and deep water)	For sub-tidal vegetation to depth limited by water clarity. Inter-tidal and supra-tidal vegetation can have water on top. Not possible for turbid water, optical imagery only. Clouds, strong winds and breaking waves, optical imagery only. Acoustic depends on seagrass species and its above ground biomass Water depth less then draft boat and water based acoustic sensors	Landsat TM/ETM SPOT Ikonos/Quickbird CASI/Hymap Aerial photography Side-scan sonar
Seagrass (Species Composition)	Operational for optical sensors (optically shallow water) Operational for active in water sensors (optically shallow and deep	For sub-tidal vegetation to depth limited by water clarity. Inter-tidal and supra-tidal vegetation can have water on top. Not possible for turbid water, optical imagery only. Clouds, strong winds and breaking	Landsat TM/ETM SPOT Ikonos/Quickbird CASI/Hymap Aerial photography Side-scan sonar

	water)	waves, optical imagery only. Acoustic depends on seagrass species and its above ground biomass Water depth less then draft boat and water based acoustic sensors	
Seagrass (Percent Cover [horizontal projected foliage])	Feasible (optically shallow water)	For sub-tidal vegetation to depth limited by water clarity. Inter-tidal and supra-tidal vegetation can have water on top. Not possible for turbid water, optical imagery only. Clouds, strong winds and breaking waves, optical imagery only. Acoustic depends on seagrass species and its above ground biomass Water depth less then draft boat and water based acoustic sensors	Landsat TM/ETM SPOT Ikonos/Quickbird CASI/Hymap Aerial photography Side-scan sonar
Seagrass (Total (above+below ground Biomass)	Operational (optically shallow water)	For sub-tidal vegetation to depth limited by water clarity. Inter-tidal and supra-tidal vegetation can have water on top. Not possible for turbid water, optical imagery only. Clouds, strong winds and breaking waves, optical imagery only. Acoustic depends on seagrass species and its above ground biomass Water depth less then draft boat and water based acoustic sensors	Landsat TM/ETM SPOT Ikonos/Quickbird CASI/Hymap Aerial photography Side-scan sonar
Harmful Algal Blooms Presence/absence *e.g. Lyngbya majuscula*	Operational (optically shallow ater)	For sub-tidal vegetation to depth limited by water clarity. Inter-tidal and supra-tidal vegetation can have water on top. Not possible for turbid water, optical imagery only. Clouds, strong winds and breaking waves, optical imagery only. Lyngbya % cover > 40%	Landsat TM/ETM Hyperion CASI/Hymap Quickbrid Ikonos
Harmful Algal Blooms % Cover (*e.g. Lyngbya*	Operational (optically shallow water)	For sub-tidal vegetation to depth limited by water clarity. Inter-tidal and supra-tidal vegetation	Landsat TM/ETM Hyperion CASI/Hymap

majuscula)		can have water on top. Not possible for turbid water, optical imagery only. Clouds, strong winds and breaking waves, optical imagery only. Lyngbya % cover > 40%	Quickbrid Ikonos
Harmful Algal Blooms e.g. Lyngbya majuscula (Biomass)	Research (optically shallow water)	For sub-tidal vegetation to depth limited by water clarity. Inter-tidal and supra-tidal vegetation can have water on top. Not possible for turbid water, optical imagery only. Clouds, strong winds and breaking waves, optical imagery only.	Landsat TM/ETM Hyperion CASI/Hymap Quickbrid Ikonos
Coral Reef Composition: Reef Extent	Operational (optically shallow water)	Not possible for turbid water, optical imagery only. Clouds, strong winds and breaking waves, optical imagery only.	MERIS MODIS Landsat TM/ETM SPOT Ikonos/Quickbird CASI/Hymap Aerial photography
Coral Reef Composition: Coarse Spatial Scale (e.g. geomorphic zones)	Operational (optically shallow water)	For sub-tidal vegetation to depth limited by water clarity. Inter-tidal and supra-tidal vegetation can have water on top. Not possible for turbid water, optical imagery only. Clouds, strong winds and breaking waves, optical imagery only. Water depth less then draft boat and water based acoustic sensors	Landsat TM/ETM SPOT Ikonos/Quickbird CASI/Hymap Aerial photography Side-scan sonar
Coral Reef Composition: Fine Spatial Scale (e.g. community zones)	Operational (optically shallow water) Sensor availability	For sub-tidal vegetation to depth limited by water clarity. Inter-tidal and supra-tidal vegetation can have water on top. Not possible for turbid water, optical imagery only. Clouds, strong winds and breaking waves, optical imagery only. Water depth less then draft boat and water based acoustic sensors	Ikonos/Quickbird CASI/Hymap Aerial photography Side-scan sonar Visual Airborne
Coral Reefs: Coral Cover	Operational (optically shallow	For sub-tidal vegetation to depth limited by water clarity.	Ikonos/Quickbird CASI/Hymap

	water) Sensor availability	Inter-tidal and supra-tidal vegetation can have water on top. Not possible for turbid water, optical imagery only. Clouds, strong winds and breaking waves, optical imagery only. Water depth less then draft boat and water based acoustic sensors	Aerial photography Side-scan sonar Visual Airborne Visual Diving Snorkeling
Coral Reef – Detect extent and cover Bleaching	Research (optically shallow water) Operational (visual airborne)	For sub-tidal vegetation to depth limited by water clarity. Inter-tidal and supra-tidal vegetation can have water on top. Not possible for turbid water, optical imagery only. Clouds, strong winds and breaking waves, optical imagery only.	Ikonos/Quickbird CASI/Hymap Visual Airborne Visual Diving Snorkeling
Event Based – Flood Plumes (Extent of plume and concentrations of sediments)	Operational(optically shallow water) Sensor availability	For sub-tidal vegetation to depth limited by water clarity. Inter-tidal and supra-tidal vegetation can have water on top. Not possible for turbid water, optical imagery only. Clouds, strong winds and breaking waves, optical imagery only.	MODIS/MERIS Ikonos/Quickbird Visual Airborne (extent only)
Event Based – Ship groundings (Benthic cover type)	Operational(optically shallow water) Sensor availability	For sub-tidal vegetation to depth limited by water clarity. Inter-tidal and supra-tidal vegetation can have water on top. Optical remote sensing not possible for turbid water Clouds, strong winds and breaking waves, optical imagery only.	Ikonos/Quickbird CASI/Hymap Visual Airborne Visual Diving Snorkeling Field based Video or photo surveys
Event Based – Cyclone Benthic cover type	Operational(optically shallow water) Sensor availability	For sub-tidal vegetation to depth limited by water clarity. Inter-tidal and supra-tidal vegetation can have water on top. Not possible for turbid water, optical imagery only. Clouds, strong winds and breaking waves, optical imagery only.	Ikonos/Quickbird CASI/Hymap Visual Airborne Visual Diving Snorkeling Field based Video or photo surveys
Event Based – Oil Spills	Operational Sensor Availability	Clouds(optical sensors only), strong winds and breaking waves.	Ikonos/Quickbird Radarsat/Terrasar Visual Airborne

Mangrove (% cover) (horizontal foliage projected cover)	Operational	Mangrove fringe can be narrow, smaller then pixel size Standing water on leaves of mangroves Cloud cover(optical sensors only)	Landsat TM/ETM SPOT Ikonos/Quickbird Radarsat/Terrasar
Mangroves (Extent)	Operational	Cloud cover Mangrove fringe can be narrow, smaller then pixel size Strong winds for airborne sensors	Landsat TM/ETM SPOT Ikonos/Quickbird CASI/Hymap Aerial photography
Mangroves (Species)	Operational	Cloud cover Mangrove fringe can be narrow, smaller then pixel size Strong winds for airborne sensors	Landsat TM/ETM SPOT Ikonos/Quickbird CASI/Hymap Aerial photography
Mangroves (Biomass)	Operational	Mangrove fringe can be narrow, smaller then pixel size Standing water on leaves of mangroves	Radarsat/Terrasar
Saltmarsh (% Cover)	Operational	Cloud cover Saltmarsh fringe can be narrow, smaller then pixel size Standing water levels	Landsat TM/ETM SPOT Ikonos/Quickbird CASI/Hymap Aerial photography
Saltmarsh (Species)	Operational	Cloud cover Saltmarsh fringe can be narrow, smaller then pixel size Standing water levels	Landsat TM/ETM SPOT Ikonos/Quickbird CASI/Hymap Aerial photography
Saltmarsh ((above-ground biomass)	Operational	Saltmarsh fringe can be narrow, smaller then pixel size Standing water on leaves of Saltmarsh	Radarsat/Terrasar
Mean High and Low Water Lines (Water body – dry land)	Operational	Clouds Strong winds for airborne sensors	Satellite Multi-spectral, Satellite Imaging Radar, Airborne Laser Altimetry
Bathymetry	Operational (optically shallow water for optical sensors) Operational (optically shallow and deep water for active sensors)	Not possible for turbid water, optical imagery only.for optical sensors Strong winds and breaking waves. Water depth less then draft boat and water based acoustic sensors	MODIS MERIS SeawiFs Landsat TM/ETM Quickbrid/ Ikonos CASI/Hymap Airborne Laser

			Scanner Side-scan sonar
Bathymetric Roughness - Rugosity	Operational (optically shallow water for optical sensors) Operational (optically shallow and deep water for active sensors)	Not possible for turbid water, optical imagery only.for optical sensors Strong winds and breaking waves. Water depth less then draft boat and water based acoustic sensors	Quickbrid/ Ikonos CASI/Hymap Airborne Laser Scanner Side-scan sonar
Water Quality Parameters – Cyano bacterial bloom (other then Lyngbya) (Surface Algal boom presence and thickness.)	Operational	Strong winds and breaking waves.	MODIS MERIS SeawiFs Landsat TM/ETM
Water Quality - Suspended Sediment Concentration	Operational (optically deep water)	Can only applied where the bottom is not visible Strong winds and breaking waves.	MODIS/MERIS Landsat TM/ETM
Water Quality – Coloured Dissolved Organic Matter (CDOM) Concentration	Operational (optically deep water)	Can only applied where the bottom is not visible	MODIS/MERIS Landsat TM/ETM
Water Quality – Chlorophyll concentration (Suspended Organic Matter Concentration)	Operational (optically deep water)	Can only applied where the bottom is not visible Unable to detect low levels of chlorophyll concentration multi spectral sensors depending on the signal to noise ratio and band locations.	MODIS/MERIS Landsat TM/ETM
Hydro- optical Properties - Attenuation Coefficients	Feasible (optically deep water)	Can only applied where the bottom is not visible Clouds, strong winds and breaking waves, optical imagery only.	MODIS/MERIS Landsat TM/ETM
Hydro-optical Properties - Euphotic Depth	Feasible (optically deep water)	Can only applied where the bottom is not visible Clouds, strong winds and breaking waves, optical imagery only.	MODIS/MERIS Landsat TM/ETM
Hydro-optical Properties - Secchi Depth	Feasible (optically deep water)	Can only applied where the bottom is not visible Clouds, strong winds and breaking waves, optical imagery only.	MODIS/MERIS Landsat TM/ETM
Sea Surface	Operational	Clouds, strong winds and breaking	MODIS/MERIS

Temperature		waves, optical imagery only.	AVHRR
Photosynthetically Active Radiation (PAR)	Operational	Clouds, strong winds and breaking waves, optical imagery only.	MODIS
Wave Height, Length and Period	Operational	???	**Scatterometer**
Surface Currents	Operational	???	**Scatterometer**
Surface Winds	Operational	???	**Scatterometer**

TSM: Total (organic + inorganic) Suspended Matter concentration in the water column
CDOM: Coloured Dissolved Organic Matter in the water column
Chl *a*: Chlorophyll a concentration in the water column
SAV: Submerged Aquatic Vegetation (seagrass, micro/macro-algae, coral)
RS: remote sensing

A number of local, national and international monitoring and management programs have built successful monitoring and management programs for coastal environments around sets of select indicators. The following list represents recognised coastal ecosystem status indicators and an established monitoring and management program using that indicator:

- Water quality parameters – Moreton Bay Ecological Health and Monitoring Program (Dennison and Abal 1999) ; (- Algal bloom characteristics – Moreton Bay Lyngbya Task force (Roelfsema et al., 2001);
- Seagrass and benthic substrate community attributes – NOAA-Coastwatch; and
- Coral reef attributes – Great Barrier Reef Marine Park Authority, Global Coral Reef Monitoring Network (Wilkinson 2000).

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