

Santos & Bitencourt (2016) - Remote sensing in the study of Brazilian mangroves: review, gaps in the knowledge, new perspectives and contributions for management. *Journal of Integrated Coastal Zone Management / Revista de Gestão Costeira Integrada*, 16(3):245-261. DOI: 10.5894/rgci662 Supporting Information

Supporting Information I

Different types of remote sensing images used to study Brazilian mangroves

Imagery type	Satellite / Sensor	Sources
Aerial photographs		Herz (1988), Braga <i>et al.</i> (1989), Machado (1992), Vale (1999, 2004), Bernardy (2000), Oliveira (2001), Krause <i>et al.</i> (2004), Lugli (2004), Cunha-Lignon (2005), Coelho (2008), Espinoza (2008), Melo (2008), Menghini (2008), Cunha-Lignon <i>et al.</i> (2009), Medeiros (2009), Santos (2009), Santos A.L.G. (2010), Santos L.C.M. (2010), Lardosa (2011), Reis-Neto <i>et al.</i> (2011, 2013), Lardosa <i>et al.</i> (2013), Santos <i>et al.</i> (2012)
Medium-resolution optical imagery	Landsat MSS, TM, ETM+	Espíndola (1986a, 1986b), Abdon <i>et al.</i> (1986, 1988), Herz (1988), Pires (1992), Bonetti (1996), Alves <i>et al.</i> (2003), Kampel & Amaral (2004), Krause <i>et al.</i> (2004), Kampel <i>et al.</i> (2005), Souza-Filho (2005), Maia & Lacerda (2006), Noernberg <i>et al.</i> (2006), Guimarães (2007), Vieira (2007), Martins (2008), Guimarães <i>et al.</i> (2009), Martins & Wanderley (2009), Medeiros (2009), Silva (2009), Almeida (2010), Araújo (2010), Jesus (2010), Magris & Barreto (2010), Silva (2010), Cunha-Lignon <i>et al.</i> (2011), Cunha-Lignon & Kampel (2011), Silva (2012), Lardosa <i>et al.</i> (2013), Reis-Neto <i>et al.</i> (2013), Silva <i>et al.</i> (2013), Godoy (2015)
	CBERS CCD	Kampel & Amaral (2004), Kampel <i>et al.</i> (2005), Guimarães (2007), Guimarães <i>et al.</i> (2009), Santos <i>et al.</i> (2009), Santos L.C.M. (2010), Santos & Bitencourt (2013), Santos <i>et al.</i> (2014), Santos <i>et al.</i> (2015), Santos <i>et al.</i> (<i>in press</i>)
	ASTER	Krause <i>et al.</i> (2004)
	SPOT HRV	Vieira (2007), Medeiros (2009), Lardosa <i>et al.</i> (2013)
High-resolution optical imagery	IKONOS	Andrade <i>et al.</i> (2010), Vasconcelos (2009), Vasconcelos <i>et al.</i> , 2011, Almeida, <i>et al.</i> (2014)
	SPOT HRG	Santos (2010b), Santos <i>et al.</i> (2014), Tenório <i>et al.</i> (2015)
	QuickBird	Espinoza (2008), Araújo (2010)
	WorldView GeoEye	Meneghetti (2013), Meneghetti & Kux (2014), Arasato <i>et al.</i> (2015) Tenório <i>et al.</i> (2015)
SAR images		Herz (1991), Souza-Filho; Paradella (2003), Souza-Filho <i>et al.</i> (2011), Pereira (2011), Pereira <i>et al.</i> (2012)
Integration of SAR and optical imagery		Souza-Filho (2000, 2005), Lara <i>et al.</i> (2002), Souza-Filho & Paradella (2002), Cohen & Lara (2003), Souza-Filho <i>et al.</i> (2005, 2006, 2009), Batista <i>et al.</i> (2009), Santos <i>et al.</i> (2009), Silva <i>et al.</i> (2009), Teixeira & Souza-Filho (2009), Costa (2010), Dantas <i>et al.</i> (2011), Rodrigues & Souza-Filho (2011), Nascimento <i>et al.</i> (2013), Arasato <i>et al.</i> (2015a, 2015b).

Supporting Information II

Remote sensing analysis techniques applied on the studies of Brazilian mangroves.

Remote sensing techniques	Sources
Visual analysis	Braga (1989), Herz (1988, 1991), Machado (1992), Vale, (1999, 2004), Lara <i>et al.</i> (2002); Cohen & Lara (2003), Krause <i>et al.</i> (2004), Souza-Filho (2005), Noernberg <i>et al.</i> (2006), Martins & Wanderley (2009), Andrade <i>et al.</i> (2010), Magris & Barreto (2011), Souza-Filho <i>et al.</i> (2011), Cunha-Lignon (2005), Melo (2008), Menghini (2008), Teixeira & Souza-Filho (2009), Santos <i>et al.</i> (2009), Santos A.L.G. (2010), Santos L.C.M. (2010), Rodrigues & Souza-Filho <i>et al.</i> (2011), Reis Neto <i>et al.</i> , (2011, 2013); Lardosa <i>et al.</i> (2013), Santos <i>et al.</i> (2014)
Supervised classification	Herz (1988), Bonetti-Filho (1996), Kampel & Amaral (2004), Krause <i>et al.</i> (2004), Kampel <i>et al.</i> (2005), Guimarães (2007), Guimarães <i>et al.</i> (2009), Santos <i>et al.</i> (2009), Araújo (2010), Cunha-Lignon & Kampel (2011), Rodrigues & Souza-Filho (2011) Souza-Filho <i>et al.</i> (2011), Santos <i>et al.</i> (2014), Godoy (2015)
Unsupervised classification	Kampel & Amaral (2004), Kampel <i>et al.</i> (2005), Santos <i>et al.</i> (2009), Silva (2012)
Vegetation Index	Alves <i>et al.</i> (2003), Krause <i>et al.</i> (2004), Noernberg <i>et al.</i> (2006), Espinoza (2008), Silva (2009), Araújo (2010), Silva (2012), Santos & Bitencourt (2013), Arasato <i>et al.</i> (2015a), Santos (2015), Santos <i>et al.</i> (2015), Santos <i>et al.</i> (<i>in press</i>).
Segmentation	Kampel & Amaral (2004), Krause <i>et al.</i> (2004), Kampel <i>et al.</i> (2005), Vasconcelos (2009), Almeida (2010), Araújo (2010), Almeida, <i>et al.</i> , (2011), Cunha-Lignon & Kampel (2011), Nascimento <i>et al.</i> (2013), Silva <i>et al.</i> (2013)
Object-Based-Image-Analysis (OBIA)	Vasconcelos <i>et al.</i> (2011); Meneghetti (2013), Silva <i>et al.</i> (2013), Nascimento <i>et al.</i> (2013), Almeida <i>et al.</i> (2014), Meneghetti & Kux (2014), Arasato <i>et al.</i> (2015a)

Supporting Information III

Applications and limitations of different types of remote sensing images used to study mangroves

Imagery type	Applications and Benefits	Limitations
Aerial photographs	<ul style="list-style-type: none"> • Detailed mapping and acquisition of information on local scale • Discrimination of plant species • Detection of spatial and temporal changes in broad timescale • Collection of information prior to the availability of satellite images • Assessment of mappings conducted with lower resolution images • Qualitative analysis: visual interpretation • Freely available if requested for research purposes in state agencies or universities, if there was an aerial survey acquired by the institution 	<ul style="list-style-type: none"> • Difficult to map large areas • Quantitative analysis
Medium-resolution optical imagery	<ul style="list-style-type: none"> • Mapping of medium to large extent of mangrove areas and acquisition of information on local, regional and national scales • Discrimination of types of mangrove vegetation (conservation status, environmental stress, density of vegetation cover) • Detection of spatial and temporal changes and monitoring vegetation in wide and short timescale • Obtaining information about the green biomass of vegetation • Quantitative analysis: vegetation index, supervised/unsupervised classifications, segmentation. • Some images are freely available, such as those from Landsat and CBERS. 	<ul style="list-style-type: none"> • Detailed mapping of vegetation cover • Discrimination of plant species • Qualitative analysis of images with spatial resolution more than 30 m • Some images can be very expensive
High-resolution optical imagery	<ul style="list-style-type: none"> • Detailed mapping and acquisition of information on local scale • Discrimination of plant species and species dominance • Acquisition of information and data about canopy structure and green biomass • Detection of spatial and temporal changes in short timescale • Assessment of mappings conducted with lower resolution images • Quantitative analysis: OBIA, vegetation index, supervised/unsupervised classifications, segmentation. • Qualitative analysis: visual interpretation 	<ul style="list-style-type: none"> • Difficult to map large areas • Detection of spatio-temporal changes in broad timescale • Images are very expensive
SAR images	<ul style="list-style-type: none"> • Mapping mangroves in large extent area and acquisition of information on local, regional and national scales • Discrimination of types of mangrove vegetation (conservation status, environmental stress) • Obtaining information on the moisture content and salinity, vegetation structure and above-ground biomass • Mapping mangroves in areas with high cloud cover, or in presence of smoke fire • Quantitative and qualitative analysis 	<ul style="list-style-type: none"> • Discrimination of plant species • Extremely skilled analysts with experience in radar-image processing needed • Some images can be very expensive
Integration of SAR and optical imagery	<ul style="list-style-type: none"> • Combination of the above applications and benefits described for SAR and optical imagery. • Multiscale mappings and studies. • Estimating total biomass: green and above-ground (branches, stems and trunks) biomass. 	<ul style="list-style-type: none"> • Combination of the above limitations described for SAR and optical imagery • Different approaches to process optical and SAR imagery