Introducing fuzzy set theory to evaluate risk of misclassification of land cover maps to land mapping applications: testing on coastal watersheds. *Ocean and Coastal Management*. Supplementary methods.
https://doi.org/10.1016/j.ocecoaman.2019.104903

Introducing fuzzy set theory to evaluate risk of misclassification of land cover maps to land mapping applications: testing on coastal watersheds

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Supplementary Methods

1. Selection of land cover rates

Land cover rates are highly dependent on the land mapping application. In this study, two land mapping applications were selected: Water-level attenuation role in the assessment of inundation extents during flood events in coastal areas; and Impervious quantifications for watershed management.

Application 1| Water-level attenuation role in the assessment of inundation extents during flood events in coastal areas

Assessments of coastal flood exposure and risk are required to inform mitigation and adaptation decisions to climate change (Dolan and Walker, 2004). From a socio-economic view, one of the most critical issues is to determine inundation extent in order to evaluate the risk to populations. Along with distance from coast and elevation, water-level attenuation from land cover plays a significant role in determining inundation extent in coastal areas. Mangroves in South Florida, for instance, have attenuated water-level during Hurricane Wilma up to 50 cm km-1 (Liu *et al*. 2013); and urban and residential areas have been shown to significantly decrease inundation extent (Vafeidis *et al*. 2019). Vafeidis *et al*. (2019) present a set of water-level attenuation rates per land cover category, which we have adapted for the purpose of this study (Table SM.1).

Table SM.1
Maximum water-level attenuation rates per land cover category used to determine the relevance of classification errors (adapted from Vafeidis *et al*. 2019).

Land use category	Maximum attenuation (cm km-1)
Urban	100
Forest	50
Mangroves	50
Restinga	50
Agriculture	40
Aquaculture	0
Water	0

Application 2 | Impervious quantifications for urban watershed management

Land cover types, and their arrangement, have been used to explore variation in water quality (Alberti *et al.*, 2007; Shandas and Alberti, 2009; Teixeira and Marques, 2016), demonstrating that impervious surfaces contribute to declining water quality (Booth and Jackson, 1997; Schueler *et al*., 2009), amplifying the transport of polluted stormwater runoff (Tang *et al*., 2011). Although the general relationship between impervious surface and water quality is well-established, Schueler *et al*. (2009) found out that water quality varies greatly among watersheds with similar levels of impervious surface, as a result of different land cover patterns. According to these authors, in urban watersheds, the impact of stormwater runoff is, in part, determined by vegetation patterns. For one hand, forests absorb runoff with greater efficiency than grass (Brabec *et al*., 2002) and agriculture (Wang *et al*., 2018), although this pattern might change in steeper slopes (Wang *et al*., 2018); for another, grass and agriculture tend to intensify pollution concentrations in surface water runoff due to the use of chemicals and fertilizers (St-Hilaire *et al*., 2016). Moreover, though studies have shown that the effectiveness of riparian buffers decreases in urban watersheds (Pratt and Chang, 2012; Walsh *et al*., 2004), these vegetated zones still play a significant role in halting surface runoff (Boongaling *et al*., 2018) and decreasing water pollution (Chua *et al*., 2019; St-Hilaire *et al*., 2016). Based on the information provided by the literature, the impervious rate of our seven land categories was established (Table SM.2). Although forest is frequently considered a sink, a rate of 10 was assigned to this category to account for forests associated with steep slopes (Wang *et al*. 2018).

Table SM.2
Imperviousness rates per land cover category used to determine the relevance of classification errors.

Land use category	Impervious rate
Urban	100
Agriculture	30
Forest	10
Aquaculture (Unknown)	0
Mangroves	0
Restinga	0
Water	0

2. Calculation of land cover rates' differences

Once the land cover rates have been established (Table SM.1 and Table SM.2), the difference between the land cover rates is calculated (Table SM.3).

Table SM.3
Difference between the rates for two land applications.

	agriculture	aquaculture	mangrove	restinga	urban	water	rainforest
Application 1 | Water-level attenuation role in the assessment of inundation extents during flood events							
agriculture	0						
aquaculture	40	0					
mangrove	10	50	0				
restinga	10	50	0	0			
urban	60	100	50	50	0		
water	40	0	50	50	100	0	
rainforest	10	50	0	0	50	50	0
Application 2 | Impervious quantifications for urban watershed management							
agriculture	0						
aquaculture	30	0					
mangrove	30	0	0				
restinga	30	0	0	0			
urban	70	100	100	100	0		
water	30	0	0	0	100	0	
rainforest	20	10	10	0	90	10	0

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