										maximum likelihood algorithm		2013)
2013	2010	Shangyu City, Zhejiang Province, China	Cfa	local (260.61 km^2)	•		•		ALOS/PALSAR	Inversion model based on a backscattering coefficient semi-variogram, kriging and co-kriging	Parent material	(Guo et al., 2013)
2013	2008	South Australia	BSk (Cold Arid Steppe)	local (159 km^2)	•		•		QuickBird	Unsupervised classification and utilizing salinity indices	Patches of dry saline land and dryland salinity	(Setia et al., 2013)
2013	2010	Khuzestan, Iran	BWh (Hot Arid Desert)	local (774 km^2)	•		•	•	Hyperion	Linear regression analysis	Presence of salt-containing layers, parent material, irrigation with saline water, high groundwater table, high evaporation rates, sediment transport during flood periods and seawater intrusion	(Hamzeh et al., 2013)
2013	1975 and 2004, 2005	Ardakan Area ,Iran	BSk (Cold Arid Steppe)	local	•		•		Landsat MSS and TM	Supervised classification		(Matinfar et al., 2013)
2012	1990-2003	Basrah Province, Iraq	BWh (Hot Arid Desert)	local (19 070 km^2)	•		•	•	Landsat 5 TM, Landsat 7 ETM+	Digital image classification and band match methods. land use classification using both unsupervised and supervised techniques	High evapotranspiration rate, low precipitation, high mineralization of groundwater, human-induced activities	(Jabbar & Zhou, 2012)
2012	2007	Mexico	BWh (Hot Arid Desert)	local (920 km^2)	•		•		Landsat 5 Thematic Mapper (TM)	Regression analysis, utilizing indices		(Judkins & Myint, 2012)
2012	2005	Yinchuan Plain ,China	BWk (Cold Arid Desert)	local (7790 km^2)	•		•		MODIS	Utilizing NDVI index, correlation analysis		(Jin et al., 2012)
2012	2006 to 2009	Jezre'el Valley, Israel	Csa	local (0.8 km^2)		•			AISA-Dual sensor	Partial least squares regression model, correlation analysis		(Goldshleger et al.,2012)
2012	2002	Aral Sea Basin, Uzbekistan	BWk (Cold Arid Desert)	local (15 km^2)	•		•		Landsat 7	Neural network model		(Akramkhanov & Vlek, 2012)
2012	1985, 1999, and 2006	Yellow River Delta, China	Dwa	local	•		•		Landsat TM	Utilizing NDVI and salinity indices, Regression analysis		(Fan et al., 2012)
2011	2009	Yinchuan Plain , China	BWk (Cold Arid Desert)	local (7793 km^2)	•		•		HJ - I	Support vector machine (SVM) classification	Topography, hydrology, irrational agricultural practices	(Meimei & Ping, 2011)
2011	2008	Northeast Brazil	Aw, BSh, BWh	regional	•		•		MODIS	Linear spectral unmixing technique (LSU), utilizing salinity indices, multiple linear regression	Inappropriate irrigation, parent material	(Bouaziz et al., 2011)
2011	2001	Central Punjab Province, Pakistan	BSh (Hot Arid Steppe)	local	•		•		Landsat 7 ETM+	Utilizing salinity indices	High evaporation	(Iqbal, 2011)
2011	1990-2002	Khorezm Province, Uzbekistan	BWk (Cold Arid Desert)	local	•		•	•	Landsat 7	Utilizing spectral indices of normalized difference vegetation indices (TNDVI), soil-adjusted vegetation index (SAVI) and ratio vegetation index (RVI), regression analysis	Shallow groundwater table	(Akramkhanov et al., 2011)
2011	1995	Indira Gandhi Mukhya Nahar, India	BWh (Hot Arid Desert)	local	•		•		IRS LISS II	Utilizing NDVI and SAVI indices visual interpretation	Flood irrigation practice, canal seepage, sandy soil texture and absence of natural surface drainage	(Mandal & Sharma, 2011)
2011	2000	Al-Hassa Oasis, Saudi Arabia	BWh (Hot Arid Desert)	local	•		•		Landsat TM 5	Utilizing NDVI and SAVI indices	Irrigation water	(Aldakheel, 2011)
2010	1991-2005	Inner Mongolia, China	BWk (Cold Arid Desert)	local	•		•		Landsat TM, ETM+	Supervised classification and visual interpretation, maximum-likelihood supervised method	Unfavorable topography, geomorphology, soil texture and irrigation???	(Yu et al., 2010)
2010	1986 to 2005	Rio Conchos Basin in Northern Mexico	BSk (Cold Arid Steppe)	local	•		•		Landsat 5	Principal Component analysis (PCA), maximum likelihood classification, visual interpretation	Mineral deposits scattered throughout the area	(Gutierrez and Johnson, 2010)
2010	2000, 2004 and 2007	Southern Alicante Province, Spain	BSk (Cold Arid Steppe)	local	•		•		ASTER	Matched filtering (MF) and mixture tuned matched filtering (MTMF), linear spectral unmixing (LSU)	Inappropriate Irrigation	(Melendez-Pastor et al., 2010)
2010	1983–2000	Golodnaya Steppe, Uzbekistan	Dsa	local (8 km^2)	•	•	•		Landsat 7,aerial photo,	Visual interpretation	Irrigation water include high content of salts with a predominant of chlorides and sulfates	(Rukhovich et al., 2010)
2010	2000-2006	Southern Colorado , USA	BSk (Cold Arid Steppe)	local	•		•		Landsat 5, Landsat 7	Regression analysis ordinary kriging, regression kriging, and co-kriging	Salinity levels in the irrigation canals	(Lobell et al., 2010)

2010	2006	Southeastern Oregon, USA	BSk (Cold Arid Steppe)	local	.	.		Landsat TM	Decision-tree analysis (DTA), utilizing salinity indices	Irrigation water flows to nearby low-lying areas resulting in higher groundwater table	(Elnaggar & Noller, 2009)
2010	2005	Yellow River Delta ,China	Dwa	local	.	.		EO-1 Hyperion	Utilizing soil salinity spectral index (SSI) and applying univariate regression analysis	Low and flat terrain, high groundwater table, high mineralization rate, poor drainage conditions, infiltration and seawater intrusion	(WENG et al., 2010)
2010	2006	South Dakota, USA	Dfb	local (17,000 km^2)	.	.		MODIS	Correlation and regression analyses		(Lobell et al., 2010)
2009	2007	Hetao Irrigation District, Inner Mongolia	BWk (Cold Arid Desert)	local	.	.		Landsat TM	Partial least squares regression model		(Yong-hua et al.,2009)
2009	2005	Fengqui, China	Dwa	local	.	.		Landsat TM	Regression models		(Ya-kun et al., 2009)
2009	2003-2004	Point Sturt Peninsula , Australia	BSk (Cold Arid Steppe)	local (140 km^2)	.	.	.	Hyperion	Partial spectral unmixing techniques, matched filtering (MF), and mixture tuned matched filtering (MTMF)	Quaternary and Tertiary sediments that contain vast salt stores	(Dutkiewicz et al., 2009)
2008	2004	Colorado, USA	Cfa	Local (1056 km^2)	.	.		Ikonos, Landsat 5	Ordinary least squares model, ordinary kriging	-	(Eldeiry et al., 2008)
2008	1973 -2006	Inner Mongolia, China	Bsk (Cold Arid Steppe)	local	.	.		Landsat MSS, TM	Maximum likelihood classification	Poor quality Irrigation water	(Wu et al., 2008)
2008	2006	Salt Lake, Turkey	BSk (Cold Arid Steppe)	local- (1500 km^2)	.	.		Landsat-5 TM	Regression analysis		(Ekercin & Ormeci,2008)
2008	2000-2002	New South Wales, Australia	BSh (Hot Arid Steppe)	local- (900 km^2)	.	.	.	Landsat-5 TM	Utilizing salinity index (SI), normalized difference salinity index (NDSI) and brightness index (BI), supervised fuzzy classification, regression-kriging	-	(Odeh & Onus, 2008)
2008	2004	Tadla Region , Morocco	Csa	local- 3600 km^2)	.	.	.	Advanced Land Imaging (EO-1)	Utilizing salinity indices	-	(Bannari et al., 2008)
2008	1996	Ardakan, Damghan, Lut Desert (Yardang Area), Abarkooh, Qom, Iran	BSk (Cold Arid Steppe)	regional	.	.		Landsat TM and ETM	Image classification and correlation analysis	Maximum evaporation, extreme conditions of soil salinity, pronounced difference between the dry surface and wet zone conditions	(Alavi Panah et al., 2008)
2008	2004-2006	Colorado, USA	BSk (Cold Arid Steppe)	local(500 km^2)	.			Ikonos,Landsat 5	Correlation analysis, ordinary least squares (OLS), spatial autoregressive (spatial AR) modeling, and modif ed residual kriging modeling	Saline river	(Eldeiry & Garcia, 2008)
2007	1980 and 2000	Changling County, China	Dwa	local (5728.4 km^2)	.	.		Landsat TM	Cellular automata (CA) model	Low precipitation	(Xiaoxia et al., 2007)
2007	2000 to 2005	San Luis Rio Colorado Valley (SLRCV) in Sonora, Mexico	BWh (Hot Arid Desert)	local (130 km^2)	.	.	.	ASTER, Landsat (TM and ETM+)	Regression analysis, statistical analysis, correlation analysis		(Lobell & Ortiz-monasterio, 2007)
2007	2002-2003	Northwestern China	BWk (Cold Arid Desert)	regional	.	.		ASTER	Spectral correlation mapper (SCM) algorithm Regression analysis	Rise in the groundwater table	(Brunner et al., 2007)

Geographical coordinates of all selected case study areas associated with monitoring soil salinity via RS technology were plotted on the Köppen-Geiger Climate classification map as shown in Figure 4. Location of some case studies on the map is so close to each other and when the coordinates of those studies are shown in worldwide scale, they overlapped each other. The map illustrates that majority of the studies conducted in the north hemisphere between latitudes 10°0’0”N and 50°0’0”N. This belt includes the most arid and semi-arid regions of the world. The overview demonstrates that almost 63% of the selected case studies are located in arid and semi-arid regions of the world like Middle East countries, India, China, United States and some European countries where protecting lands from soil salinization and erosion are becoming a major concern for agricultural productivity. In fact, preserving agricultural lands and food supply for rapidly increasing population in these regions is highly troubled.

As shown in Table 1, the main reasons of soil salinization are investigated for each selected case study. Results indicate that both primary and secondary salinization can be considered as causes of soil salinity. Exploring studies which are performed in arid and semi-arid regions of the world points out that high evapotranspiration and low precipitation rates together with the presence of minerals and parent material are the most common primary courses of soil salinization. Despite, in some cases which are located in the coastal regions, seawater intrusion is considered as another reason. Concerning secondary salinization, it is explored that poor agricultural irrigation practices and inappropriate drainage systems lead to accumulation of salts in the soil profile, and also cause rise of groundwater table.

Conclusions and Recommendations

Information on the climate regime and spatial extent of the selected case study areas, sensing approaches, and analysis and mapping methods were summarized to determine the current status of RS technology on detecting soil salinity in this review article. Ecological and economic importance of land has encouraged decision-makers of many countries to utilize RS for monitoring soil properties with the aim of optimizing sustainable land-use, boosting agricultural productivity, lessening drought effects, minimizing soil salinization and preventing soil erosion and compaction. Novelty of this study lies on the fact that geographical location of the selected case studies was plotted on Köppen-Geiger climate classification map for understanding the geographical location of these researches, and more importantly, for recognizing a relationship between soil salinity and climatic zones of case studies. The fact that 63% of the selected case studies are conducted in arid and semi-arid regions of the world indicates that soil salinization is becoming a major concern in many nations especially in such regions, and it is expected to affect countries of arid zones more vigorously and widely in the coming years if no protective measures are taken.

Further analysis and assessment at various levels extending from local to continental scale, are required to cope with the problem of soil salinity and its consequences. The most commonly used and recent RS mapping methods including support vector machine (SVM) method, random forest (RF) regression models, principle component analysis (PCA), partial least square regression (PLSR) analysis, multiple regression analysis, neural network model and various spectral soil salinity indices derived mostly from visible bands of electromagnetic spectrum were summarized. In addition to Landsat satellite systems, recently launched medium resolution satellites with multi-spectral data collection capability such as Chinese Huan Jing (HJ-1A), ESA Sentinel satellites being widely available have a strong potential to be used in soil salinity monitoring and mapping research with their temporal resolution capabilities.

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