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Assessing the long-term evolution of abandoned salinized farmland via temporal remote sensing data

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Salinization in arid or semiarid regions with water-logging limits cropland yield, threatening food security. The highest level of farmland salinization, that is, abandoned salinized farmland, is a trade-off between inadequate drainage facilities and sustainable farming. The evolution of abandoned salinized farmlands is closely related to the development of cropping systems. However, detecting abandoned salinized farmland using time-series remote sensing data has not been investigated well by previous studies. In this study, a novel approach was proposed to detect the dynamics of abandoned salinized farmland using time series multi-spectral and thermal imagery. Thirty-two years of temporal Landsat imagery (from 1988 to 2019) was used to assess the evolution of salinization in Hetao, a two-thousand-year-old irrigation district in northern China. As intermediate variables of the proposed method, the crop-specific planting area was retrieved via its unique temporal vegetation index (VI) pattern, in which the shape-model-fitting technology and the k-means cluster algorithm were used. The desert area was stripped from the clustered non-vegetative area using its distinct features in the thermal band. Subsequently, the abandoned salinized farmland was distinguished from the urban area by threshold-based saline index (SI). In addition, a regression model between electrical conductance (EC) and SI was established, and the spatial saline degree was evaluated by the SI map in uncropped and unfrozen seasons. The results show that the cropland has constantly been expanding in recent decades (from $4.7*10^5$ ha to $7.1*10^5$ ha), while the planting area of maize and sunflower has grown and the area of wheat has decreased. Significant desalinization progress was observed in Hetao, where both the area of salt-affected land (salt-free area increased approximately $4*10^5$ ha) and the abandoned salinized farmland decreased (reduced from 0.45 $*10^5$ ha to 0.19 $*10^5$ ha). This could be mainly attributed to three reasons: the popularization of water-saving irrigation technology, the construction of artificial drainage facilities, and a shift in cropping patterns. The decrease in irrigation and the increase in drainage have deepened the groundwater table in Hetao, which weakens the salt collection capacity of the abandoned salinized farmland. The results demonstrated the promising possibility of reutilizing abandoned salinized farmland via a leaching campaign where the groundwater table is sufficiently deep to stop salinization.