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COMMENT

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Reply to "Comment on 'Soil salinity assessment by using near-infrared channel and Vegetation Soil Salinity Index derived from Landsat 8 OLI data: a case study in the Tra Vinh Province, Mekong Delta, Vietnam' by Kim-Anh Nguyen, Yuei-An Liou, Ha-Phuong Tran, Phi-Phung Hoang and Thanh-Hung Nguyen"

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Abstract

The Vietnamese Mekong Delta has been devastatingly impacted by climate change coupled with sea level rise and natural hazards. As a result, salinity intrusion has become a pressing issue in the coastal provinces of the Mekong Delta in recent years. This environmental problem has called a great attention from the global scientists as demonstrated by the paper Nguyen et al. (Prog Earth Planet Sci 7:1, 2020. 10.1186/s40645-019-0311-0) "Soil salinity assessment by using an indicator derived from Landsat 8 OLI data: A case study in the Tra Vinh, Mekong Delta, Vietnam" (reached 27 k accesses as of July 31, 2022). Recently, Silvestri et al. (PEPS, 2022) have commented on Nguyen et al. (2020) article with three main points highlighted: (1) Within the coastal portion of the Mekong Delta, extensively ponded due to widespread shrimp farming, about 90% of Landsat 8 pixels are fully or partially covered by water so that Landsat 8 OLI spatial resolution is not suitable to distinguish between ponded and non-ponded areas; (2) The decreased near-infrared (NIR) reflectance ascribed to increased soil salinity is instead due to the presence of water in Landsat 8 mixed pixels; and (3) NIR reflectance is equally reduced independently of whether the water ponding area is salt or freshwater. We appreciate Silvestri et al. (2022) for their correspondence regarding our 2020 article (Nguyen et al. 2020) where we showed the capacity of using freely accessible Landsat 8 OLI image for the rapid soil salinity detection at the top soil layer in the agricultural land that is of valuable information for agricultural activities. We conducted field survey and collected the soil samples during the dry season at different agricultural soil types. Notably, the soil samples were collected at the same time with the satellite passing over the study area. The soil salinity derived from Landsat 8 is in line with the analysis from in situ data and consistent with the findings of previous studies.

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Importantly, two points are stressed in this reply: (1) The goal of our study is to utilize the freely accessible data source with rapid method of mapping soil salinity to investigate the salinity in the agricultural land, but not in the water body. Therefore, it has been a serious mistake to state that 90% of Landsat 8 pixels are fully or partially covered by water as claimed in Silvestri et al. (2022); and (2) The Tra Vinh Province has recorded the highest salinity level normally in March or April every year when the rainfall exhibits the lowest of the year, and at this time, most of the water in the river/canal is affected by saline intrusion. Thus, it is advised that Silvestri et al. (2022) should use the images acquired in March or April rather than random months.

Keywords: Soil salinity, Climate change, Landsat 8, Tra Vinh Province, Mekong Delta

1 Introduction

This article responds to the comments from Silvestri et al. (2022) who made comments on Nguyen et al. (2020) "Soil salinity assessment by using an indicator derived from Landsat 8 OLI data: A case study in the Tra Vinh, Mekong Delta, Vietnam." With lack of local agricultural practice knowledge, Silvestri et al. (2022) utilized different temporal remote sensing data and consequently distinctive landscape scenarios from Nguyen et al. (2020) to conduct their research and analysis, and draw their conclusions. Thus, it is needed and a must to alert the readers the discrepancies between Silvestri et al. (2022) and Nguyen et al. (2020). Eventually, all readers are entitled to be kept proper research background and correct research outcomes.

2 Main text

In the comment article (Silvestri et al. 2022), they performed an analysis has been performed by generating 20 grids of 10×10 cells (of 30 m $\times$ 30 m each) distributed across the ponded area. This means that the authors simultaneously reduced the resolution of Landsat 8 image as a 300 m $\times$ 300 m cell to analyze and obtain the percentage of pixels coved by water. Only one presentative point sample was used to compare with reflectance over one grid (size 300 m $\times$ 300 m). In addition, they used Google Earth images, which have higher resolution than Landsat 8 image's. However, they used the mosaic image combining images from different seasons/timeframe. Then, they pointed out that: (1) about 90% of Landsat 8 pixels are fully or partially covered by water within the coastal regions; (2) no significant correlation is found between reflectance and soil salinity; and (3) the NIR reflectance attenuation cannot be ascribed to vegetation stress caused by soil salinity, but rather to the presence of water ponds. Comment point numbers (2) and (3) are a result of comment point number (1).

We acknowledge Silvestri et al. (2022) to take a lot of efforts to reanalyze our work. Their efforts are evidence to prove the fact that our work is of great value to the scientific community, but have not demonstrated any flaws made in our work. We argue that the comments of Silvestri et al. (2022) are simply based on their inadequate knowledge of the study area environment, including aquaculture practice and climate/weather. It is crystal clear that they lack the sense to utilize the images collected with proper conditions, "*under dry environment before aquaculture practice*," as specifically addressed in Nguyen et al. (2020). The specific date (February 17, 2017) selected and dry terrain concerned in our study are clearly indicated in our work, while they have not selected the specified situations in their study. Instead, they used recent base images with random acquisition dates (collected in December 2019, March 2018 and February 2018), and the second set of cloud-free images were historically collected before February 14, 2017 (collected in January 2015, August 2014, March 2011 and January 2006). How can their results by comparing apples with oranges be reliably used for further implication or drawing conclusions for the concern of the study? Notably, the Tra Vinh Province has recorded the highest salinity level normally in March or April every year when the rainfall exhibits the lowest of the year, and at this time, most of the water in the river/canal is affected by saline intrusion. Thus, it is advised that Silvestri et al. (2022) should use the images acquired in March or April rather than random months.

Additionally, we all know that it is difficult to obtain the cloud-free optical satellite image in the Mekong Delta in the rainy season. Thus, we selected the agricultural land during dry season as the main target. Some important points in our study are highlighted here: (1) Soil samples were collected during "dry season" in the real time with Landsat 8 data. Samples were collected in "dried agricultural land, but not water body," as clearly addressed in our paper; and (2) the main purpose of our study was to investigate the salinity in the agricultural land, but not in the water body. Generally speaking, the NIR reflectance is reduced in water body. However, we must look closely at the time of the satellite image acquired, February 14, 2017. According to the aquaculture seasonal calendar of Tra Vinh Province, the shrimp farming season usually starts in February, after the Lunar New Year holiday (January 25–February 5, 2017). Before starting the new

shrimp farming season, farmers often dry the field, disinfect it to ensure that the new batch of shrimp is free from disease. Therefore, it has been a serious mistake to state that 90% of Landsat 8 pixels are fully or partially covered by water as claimed in Silvestri et al. (2022). We also compared the results of our saline intrusion map with the land use map provided by European Space Agency (ESA) (downloaded from this site: https://esa-worldcover.org/en). Most of the saline area is aquaculture land, while some locations are cropland (Fig. 1). Figure 1 shows that the reflectivity of NIR of other saline soil areas (other than water bodies) is also reduced as suggested in our work.

Furthermore, we also compared the results of our salinity map with the global soil texture map downloaded from United States Department of Agriculture (USDA) and found that there was a high degree of similarity between them as shown in Fig. 2. This similarity further confirms that our method and results are completely acceptable.

Besides, it has been frequently suggested that Landsat 8 NIR band and Vegetation Soil Salinity Index (VSSI) containing the NIR band were employed to map and monitor soil salinity over the Tra Vinh Province in the literature. Theoretically speaking, crops are subject to biotic and abiotic stress (i.e., salinity), and their photosynthetic activity declines with increasing visible reflectance and decreasing NIR reflectance (Richards 2012). Thus, a high correlation between soil salinity and NIR reflectance was found. This result was consistent with the results from Elnaggar

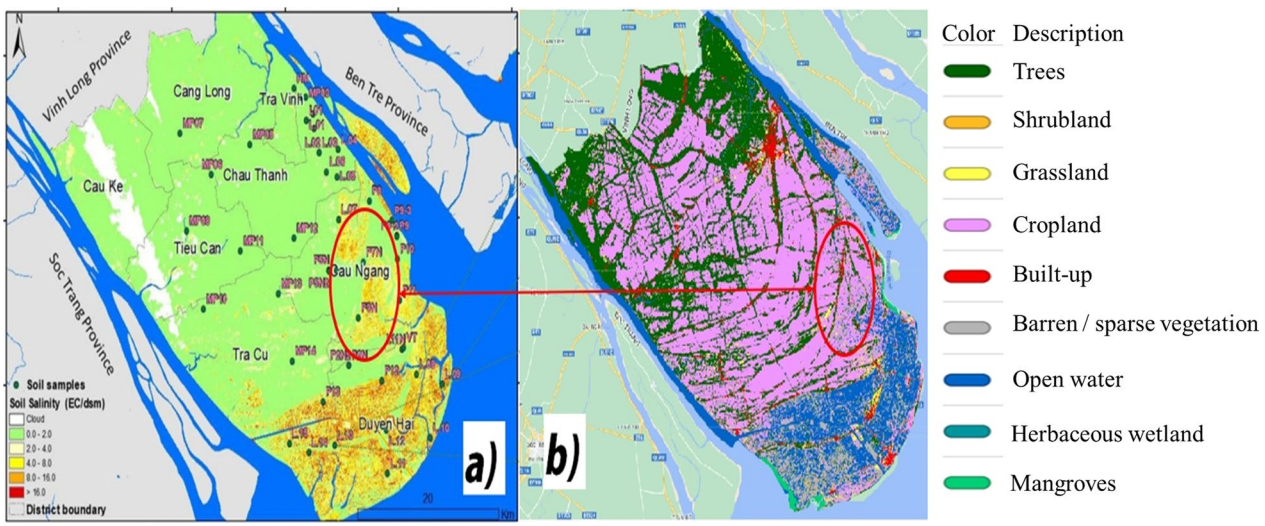

Fig. 1 Comparison of soil salinity map (**a**) created by Nguyen et al. (2020) and land cover map derived from the ESA (**b**). The land cover map was derived from the European Space Agency (ESA) World Cover with a spatial resolution of 10 m

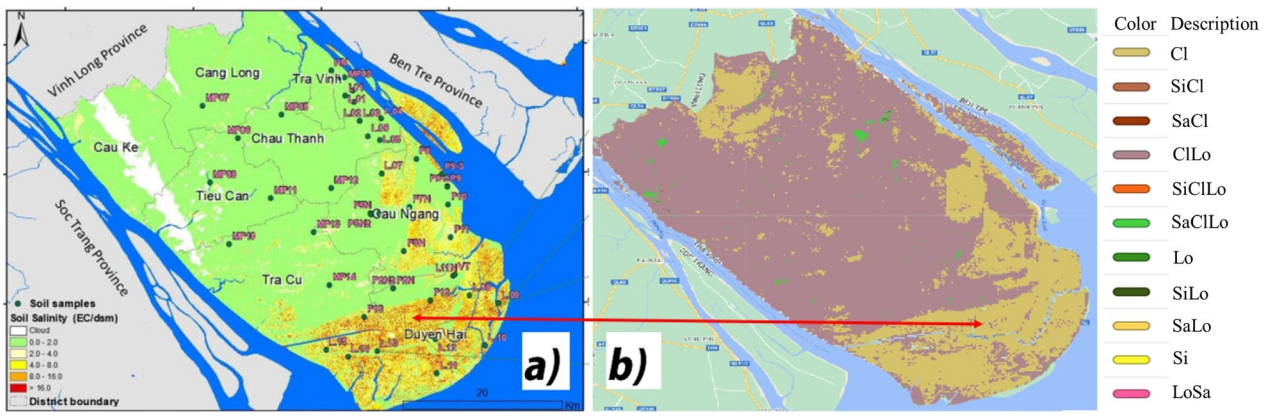

Fig. 2 Comparison of soil salinity map (**a**) created by the Nguyen et al. (2020) and soil texture map derived from the USDA system (**b**)

and Noller (2009). Dwivedi and Rao (2007) demonstrated that there is a strong correlation between salinity indexes (containing NIR band) and salinity indicator (i.e., EC). The result was in line with study results reported by Noroozi et al. (2011). As discussed in our paper, the sand dunes along the coastal zones of the Tra Vinh Province are of an average height of 1 to 3 m (Fig. 1). The height of the dunes is up to 5 m at Long Son and 10 m at Long Toan communes. These areas are featured by hot and dry climate conditions. The results revealed an insignificant relationship between electrical conductivity (EC) and NIR band for these sand patterns. The lower reflectance on the NIR band for the water region compared to those of the other land cover types is also discussed in our paper. It is true that the spatial resolution of Landsat 8 image has its limitation, and many other higher-resolution imagery can be a nicer option. Notably, the goal of our study is to target the freely accessible data source with rapid method of mapping soil salinity. Our research was conducted in 2017; at this time, Sentinel 2 data were available since 2015 could be also an option to use. Besides, we concerned with the stability and long-term monitoring of the salinity so that Landsat data were a good option at that timeframe. In addition, determining ponded and non-ponded areas using higher-resolution satellites is crucial if the detailed information about soil salinity intrusion is needed. As noted in our paper, "*an improved version of the proposed method, especially in spatial domains, will be even more beneficial to achieve higher efficiency in contributing to the orientation and planning of agricultural production areas of the salinity intrusion vulnerable regions.*" A useful knowledge from our paper provides an approach to study soil salinity and open further chances for different approaches to advance the results. In other words, our proposed method is valuable for researchers and local managers who can exploit the Landsat 8 data to determine the salinity level rapidly for long-term monitoring in Tra Vinh Province as well as the Mekong Delta.

3 Conclusions

With insufficient knowledge of research area and agricultural practice, Silvestri et al. (2022) made comments on Nguyen et al. (2020) wrongly. This article reveals the differences between the two studies and uncovers the knowledge required for the research conducted by Nguyen et al. (2020). The information presented in this article is extremely important for further research to the field.

Abbreviations

EC: Electrical conductivity; ESA: European Space Agency; NIR: Near infrared; USDA: United States Department of Agriculture; USGS: United States Geological Survey; VSSI: Vegetation Soil Salinity Index.

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Author contributions

Conceptualization was done by KAN and YAL. Data curation was done by HPT, PPH, THN, KAN and YAL. Formal analysis was done by KAN and YAL. Funding acquisition was done by YAL and THN. Investigation was done by HPT and PPH. Methodology was done by HPT. Project administration was done by HPT. Supervision was done by KAN and YAL. Writing of the original draft, reviewing, editing and revising were done by KAN and YAL. Finalization of the manuscript was done by YAL. All authors read and approved the final manuscript.

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Availability of data and materials

Please contact authors for the data supporting this study.

Declarations

Competing interests

The authors declare no competing of interest.

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