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Effect of dry land transformation and quality of water use for crop irrigation on the soil bacterial community in the Mezquital Valley, Mexico

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Soil bacteria are important determinants of soil fertility and ecosystem services as they participate in all biogeochemical cycles. Until now the comprehension of compositional and functional response that bacterial communities have to land use change and management, specifically in dry land its limited. Dry lands cover 40% of the world's land surface and its crop production supports one third of the global population. In this regions soil moisture is limited constraining farming to the rainy season or oblige to irrigate, as fresh water resources become scarce, to maintain productivity, treated or untreated wastewater for field irrigation is used. In this study the transformation of semiarid shrubland to agriculture under different land systems regarding quantity and quality of water use for crop irrigation on bacterial communities was investigated. The land systems included maize rain-fed plantations and irrigation systems with freshwater, untreated wastewater stored in a dam and untreated wastewater during dry and rainy season. Bacterial community structure and function was heavily affected by land use system and soil properties, whereas seasonality had a slighter effect. A soil moisture, nutrient and contaminant-content increasing gradient among the land use systems, going from rain fed plantation over fresh water, dam wastewater to untreated wastewater irrigated plantations was detected, this gradient diminished the abundance of Actinobacteria and Cyanobacteria, but enhanced the one from Bacteroidetes and Proteobacteria. Discernible clustering of the dry land soil communities coincides with the moisture, nutrient and contaminant gradient, being shrubland soil communities closer to the rain-fed's system and farer to the one from untreated wastewater irrigated soil. Soil moisture together with sodium content and pH were the strongest drivers of the community structure. Seasonality promoted shifts in the composition of soil bacteria under irrigation with freshwater and untreated wastewater, as these systems showed differences in soil properties between seasons such as P content and electric conductivity. Potential functional profiles revealed that differences in land use systems also influence distinct functional pathways. Nitrogen fixation, nitrification, denitrification pathways and methane metabolism are potentially enhanced in wastewater irrigation systems, while dissimilatory nitrate reduction, anammox, lignin and chitin degradation are diminished. The junction of 16S rRNA data and associated functional profiles provided extensive understanding into the bacterial community responses to changing environmental conditions associated with differences in land use, management and seasonality in drylands. Irrigation with wastewater can be potentially harmful as higher abundance of the pathogens A. baumanni, A. soli, A. junii, A. haemolyticus, A. schindleri, B. thuringiensis/anthracis,cereus and N. flavorosea was recorded in these systems.