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Regional climate impacts of irrigation and urbanization and their relevance for climate-resilient development

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Numerous studies have documented the influence of irrigation and urbanization in modulating regional climate. The importance of these land-induced climate modifications depends on many factors, including the interplay among irrigation, urbanization, and other land-surface properties as well as a region's climate regime. A clear understanding of these factors is critical for attributing regional climate change to these land modifications. Previous global studies with the Goddard Institute for Space Studies global climate model (known as ModelE) have revealed significant regional temperature and precipitation changes associated with irrigation, while other modeling studies have demonstrated the impacts of urban areas on regional climate. In this study, the ModelE is used to explore potential irrigation and urbanization impacts on climate for the key irrigated and urban areas across the globe. The ModelE is run at a resolution of approximately 1ox1o to simulate future climate with multiple scenarios for both future irrigation and urbanization conditions. These scenarios are designed to represent the changes that would be associated with strategies for climate-resilient development. These strategies include modification of urban albedos (e.g. white roofs) and urban soil moisture (e.g. reduced paved area) as well as efforts to maintain and even increase irrigation rates. The impacts on mean and extreme daily temperatures and precipitation are assessed and compared across scenarios. The results clarify that the extent to which irrigation and urban-area modification can counteract warming from increased greenhouse gas forcing depends mainly on the spatial extent and magnitude of these land-use changes, the background evaporative regime, and the secondary effects of irrigation and urbanization (e.g. clouds, precipitation). As regional authorities prepare strategies for climate-resilient development, the capacity to attribute the influence of land use on climate becomes critical. This study therefore contributes to improving the understanding of the link between development decisions and their relevance for regional climate, in order to promote effective, climate-resilient land management strategies.