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Economic value of *Nitraria retusa* in single, compound and complex nabkhas

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Arid regions are affected by many environmental challenges such as the absence of vegetation cover, lack of rain fall, increase wind erosion, which eventually increases sand and dust storm events. The upper surface of soil is vulnerable to land degradation causing the accumulation of sand around building, roads, and different man made infrastructure that cost the country tremendous amount of money yearly for mechanical sand removal. The cost of mechanical sand removal is 5.20 USD for 1 m3. Therefore, this study focuses on three different types of nabkhas namely; single plant, double plants and group of plants nabkhas. The physical and chemical properties of nabkha i.e., particle size, organic matter, moisture content, acidity, electrical conductivity were also covered. The volume of trapped sand accumulated around nabkhas are measured in cubic meters (m^3), and converted to calculated cost of mechanical sand removal. A single nabkha of *Nitraria retusa*, is capable of trapping mobile sand with a maximum of 21.9 m^3 and an average of 2 m^3. The equivalent cost of trapped sand in forming single nabkha is 10.4 USD. Hence, the efficiency of native plant species in trapping mobile sand reduces the cost of sand removal in the different forms of nabkhas. Therefore, *Nitraria retusa* as a dominant native plant in Kuwait represents valuable and efficient control measure for mobile sand and dust.

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Evaluation of GIS based mobile environmental field data collection applications

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Geographic Information System (GIS) based applications allow scientists to process and transmit data while still in the field, thereby reducing human errors and time delays. As a result, GIS based field data collection applications for mobile devices have been developed in various disciplines, including ecology, hydrology, environmental management, wildlife, geology and archaeology. Mobile GIS is fast, portable, affordable and very user friendly. Despite several software platforms available to collect and process mobile GIS data, collection of environmental data is still a challenge, mainly due to the vast quantity of attributes collected by researchers. In this study, we evaluate three data collection apps used on Windows, Android, and iOS platforms: Geocortex Mobile App Framework or GMAF (Geocortex and Latitude Geographics Product), Survey 123 and Collector for ArcGIS (Esri products). The study incorporated a development of geodatabase for different departments, development of a user-interface application and finally testing these apps in real-time field settings. We developed an "out of the box" GMAF interface for field data collection intended to be installed and used on a mobile device. The GMAF supports Android, iOS and Windows devices. GMAF allows the viewers to access native device capabilities including the file system to access large base maps while the device is offline. Despite offering multiple functionalities and tools, GMAF has some limitations with photo and file attachments. Survey 123 is form centric data collection app available for smartphones, tablets, and desktop and can be used while disconnected. Its major drawback is that it cannot collect polygons or polyline data. Collector for Arcgis is a reliable app that allows a smartphone or tablet to collect and update field data whether connected or disconnected. It collects points, lines and polygon data and attaches photos/files to the features. In addition, collector offers an intelligent data entry interface, location tracking and many other functionalities. Our evaluation suggests that according to our need, application, post-processing, compatibility and cost, collector for Arcgis would be most suitable for our existing infrastructure.

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