A theory of three-dimensional land motion in terms of its velocity field

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Abstract The present paper develops a new theory for the velocity field of land movement that may be driven by various forces, including hydraulic, seismic and gravitational forces caused, respectively, by depressurizing aquifers, earthquakes, and loading the overburden perhaps by accumulation of sedimentary deposits or by adding man-made structures. The new theory is derived from the first principles of physics (conservation of mass and linear momentum), secondary laws of physics (the viscous and drag force relation for relative flow, the constitutive law of poroelasticity and an equation of state of constituent materials), and two relations of bulk flux. Similar to Biot’s theory, the new theory can model three-dimensional deformation of saturated sedimentary material, including both volume and shear deformation. However, unlike Biot’s theory, the new model expresses itself entirely in terms of the velocity field of the skeletal frame and does not require as part of its solution scheme the coupling of motion with another physical field, such as pore-water pressure (or hydraulic head).

Key words land movement; displacement field; velocity field; land subsidence; groundwater; aquifer