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Cascading disasters in the huge coastal aquifer of Salento (Apulia region, Southern Italy) ensuing droughts

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Physical extremes can be distinguished in "sudden physical extremes" (e.g. earthquakes, tsunami) and "progressive physical extremes" (e.g. drought, desertification, landslides). They differ for frequency, intensity, spatial extent, duration and timing of occurrence. If a physical extreme, by interacting with human systems, induces negative consequences, its outcome can be a "disaster". The disasters are, in both above cases, characterized by a few phases: physical extreme occurrence, emergency, response, and recovery. However, in the case of a progressive physical extreme, the disaster develops with an overlap in the time of the above-mentioned phases.
When the events are repetitive, the emergency planning (which follows a cycle) succeeds with preparedness and mitigation with the intent of reducing the risk. Both the sudden and progressive physical extremes produce cascading effects of consequences on social, environmental and economic systems. Disasters consequent to sudden and progressive extremes show, however, some differences, mainly attributable to the "visibility" of the effects and to their time scale of evolution. As matter of fact, a disaster consequent to a progressive physical extreme produces "emerging signals" that are often invisible. Moreover, the emergency phase can arise with a time delay compared to the occurrence of the physical extreme, depending on the spatial scale of impacted system. The above differences allow defining "creeping disasters" the potential disasters related to progressive physical extremes.
This study deals with some peculiar "cascading disasters" consequent to drought, which is the main "creeping disaster", namely the groundwater drought and the consequent salinization of coastal aquifers. In regional flow systems, their effects are invisible in the immediate to common people (and often even to managers) because of the concealed nature of groundwater; moreover, they are difficult to assess because of the shift over time of their evolution compared to the promptness of surface effects. The study area is the Salento coastal karstic aquifer (Apulia region, Southern Italy), where the groundwater flows according to a regional flow system. It has been subject to successive meteorological droughts between 1960 and 2010. The groundwater monitoring performed during this period, even with some gaps, allows identifying time lags between superficial effects and underground system response, potential tipping points, and emerging signals of the cascading disasters.