Dynamics of Ground Subsidence in Beijing Plain Over Last Two Decades and Its Linkage with Government's Mitigation Policy

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SUMMARY

Ground subsidence has long been a critical geological hazard constraining the sustainable development of Beijing, China. This study investigates the spatiotemporal dynamics of ground subsidence in Beijing Plain over the past two decades (2003–2024) and its linkage with government-led mitigation policies. Based on multi-source data including InSAR monitoring results, groundwater extraction records, and urban planning documents, the research reveals two distinct evolutionary stages of ground subsidence: (1) a rapid development phase (2003–2015) driven by excessive groundwater exploitation, with subsidence reaching its peak in 2015, characterized by expanding affected areas and increasing rates; (2) a significant mitigation phase (2015–2024) attributed to the large-scale water supply from the South-to-North Water Diversion Project (SNWDP) since late 2014 and strict groundwater extraction control. The area of severe subsidence zones (subsidence rate >50 mm/a) in Beijing Plain decreased drastically from over 500 km² in 2015 to 64.94 km² in 2020, and further to only 0.60 km² in 2024. Notably, partial regions even experienced ground uplift. To address the subsidence risk, the Beijing municipal government revised the urban master plan: the 2004 version's "Two Axes–Two Belts–Multiple Centers" structure, where the Eastern Development Belt overlapped with major severe subsidence zones, was updated to the 2017 version's "Two Axes–Multiple Nodes–One Zone" layout. Severe subsidence zones were rezoned as ecological control zones or construction restriction zones, integrating ground subsidence information into spatial planning. This study demonstrates that the synergy of engineering measures (e.g., SNWDP) and policy interventions (e.g., groundwater management, planning revision) effectively mitigates ground subsidence. It provides a valuable case for integrating geological hazard monitoring data into scientific spatial planning and offers insights for subsidence control in other water-scarce urban agglomerations worldwide.