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A chaotic-dynamic approach for downscaling of global climate model (GCM) outputs: A case study for the Korean peninsula

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Together with population explosion and other socio-economic factors, natural hydroclimatic extremes (e.g. floods, droughts) crucially influence the planning and management of our water resources and environment. The vital role of these extremes in water and environmental disasters, diseases, and associated losses is abundantly clear, as 900 million people still lack access to safe drinking water, 2.5 billion people lack access to proper sanitation, millions of people die and billions of dollars are lost every year from water-related disasters and diseases. Global climate change, which is anticipated to result in more frequent and more intense hydroclimatic extremes, will most likely make our future water situation far more challenging. An important step, at the current time, in the assessment of impacts of climate change on regional and local water resources is the 'downscaling' of coarse-scale outputs from global climate models (GCMs) to catchment-scale hydroclimatic variables (especially rainfall) for use in hydrologic models. The existing downscaling techniques may be grouped under two broad categories: statistical downscaling and dynamical downscaling. Although both these techniques generally provide reasonable results, they do not explicitly take into account and adequately represent the inherent nonlinear, and in particular chaotic, dynamic nature of the climate system and the associated processes. To this end, the present study proposes a chaotic dynamic-based downscaling approach. The suitability and effectiveness of this approach are tested through its application for the Korean peninsula.