Time series Interferometric SAR (TS-InSAR) analysis represented by permanent Scatterers InSAR and small baseline subset approaches has been widely used in the field of deformation mapping. It usually assumed that the deformation process can be modelled as a dominant linear component plus a nonlinear residual. However, if the real deformation scenario presents strong nonlinearity, this kind of deformation model may bring out erroneous results. This paper presents an improved deformation model for TS-InSAR analysis. The improved model is that the deformation process can be fitted by a polynomial rather than a straight line. This model is based on the famous Weierstrass approximation theorem, that is, any continuous process can be infinitely approximated by a polynomial. Then the approach of solving the interferometric phase equations under polynomial deformation model is given. Finally the new TS-InSAR technique with the improved deformation model was tested to map ground subsidence in Taiyuan, Shanxi province of China. Totally 23 ALOS PALSAR images acquired between 2003 and 2009 are processed with the small baseline approach. In comparison, the small baseline approach with both the linear deformation model and a 3rd-order polynomial deformation model are conducted. The two results of subsidence retrieval are both compared with levelling measurements. It was demonstrated that the small baseline approach with the 3rd-order polynomial model not only can achieve more accurate deformation estimate, but also can generate denser point targets. Thus, the polynomial deformation model could replace the linear deformation model for TS-InSAR analysis in the future.