Cohomologous potentials for the two dimensional shift

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Consider the space $X = \{0,1\}^{\mathbb{Z}}$ and $Y = \{0,1\}^{\mathbb{N}}$. It is a well known fact that given a potential $V\colon X \to \mathbb{R}$ there exists a potential $v\colon Y \to \mathbb{R}$ that is cohomologous to V, i.e., such that $v = V + h \circ \sigma - h$ where σ is the shift map (the unilateral shift in Y and the bilateral shift in X).

Now consider the space $\{0,1\}^{\mathbb{Z}^2}$ and $\{0,1\}^{\mathbb{N}^2}$; in this spaces we can define two shifts, σ_x and σ_y that corresponds to the horizontal shift and to the vertical shift, and that satisfies $\sigma_x \circ \sigma_y = \sigma_y \circ \sigma_x$. Given a potential $U\colon \{0,1\}^{\mathbb{Z}^2} \to \mathbb{R}$ we are able to show that there exists a potential $u\colon \{0,1\}^{\mathbb{N}^2} \to \mathbb{R}$ such that $u = U + g \circ \sigma_x - g + h \circ \sigma_y - h$.

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