Supplementary Material

Upscaling in socio-environmental systems modelling: Current challenges, promising strategies and insights from ecology

A. Upscaling from patch to landscape scale using transition matrices

Table S1: Comparison of the rangeland model and irrigation technology example.

Characteristic	**Rangeland model (Cipriotti et al. 2016)**	**Irrigation technology diffusion**
Type of upscaling	Spatial	Organisational / spatial
Scale		
Local		
Resolution	Tuft 30cm x 30cm	Household
Extent	128 x 128 tuft cells = 0.15 ha → 1 patch	Village
Regional		
Resolution	Patch 38.4m x 38.4m	Village
Extent	135 x 210 patches = 4180 ha	Region
System properties		
Local		
Properties of local entity	Individual tuft: - State: live tussock, dead tussock or empty - Live tussock cell: green biomass, dead biomass, potential productivity Patch: - Initial vegetation condition	Household: - Technology adopted: yes/no - Personal information level (depends on # neighbours + village information level) - *Possible extension: different levels of openness to innovation* Village: - Local information level (knowledge about technology present in each village) - Average number of neighbours in village

External driver	- Precipitation - Stocking rate (constant)	- Precipitation - *Possible extension: technology subsidies*
Structure and processes included	- Water dynamics - Vegetation growth, colonisation & mortality - Grazing	- Technology adoption decision: related to number of neighbours and village information level and precipitation level
Regional		

Properties of the regional entity	- Initial vegetation state
	- Stocking rate (defined via *grazing attractiveness*)
		- Initial state of technology adoption
		- Social condition:
		  - Information level (defined via knowledge in neighbouring villages)
		  - Average number of neighbours in village

External driver	- Precipitation	- Precipitation
Additional structures and processes included	- Grazing attractiveness: determines stocking rate based on vegetation state of all cells	- Adjustment of information level based on villages in neighbourhood
Output		
Target variables (local and regional)	- Vegetation cover - Primary production - Cover of large bare gaps	- Share of HHs that adopted technology
Simplifying assumptions		
Local scale	- Only interaction between cells through water competition - Spatially homogeneous with regard to precipitation and topography	- No spatial heterogeneity with regard to precipitation
Local to regional scale	- No cross-scale interactions between small and large scale	- No cross-scale interactions between small and large scale
Regional scale	- No seed dispersal	- No long-distance interactions between villages (i.e. only next neighbours) - No other external influences (e.g. policies, etc.)

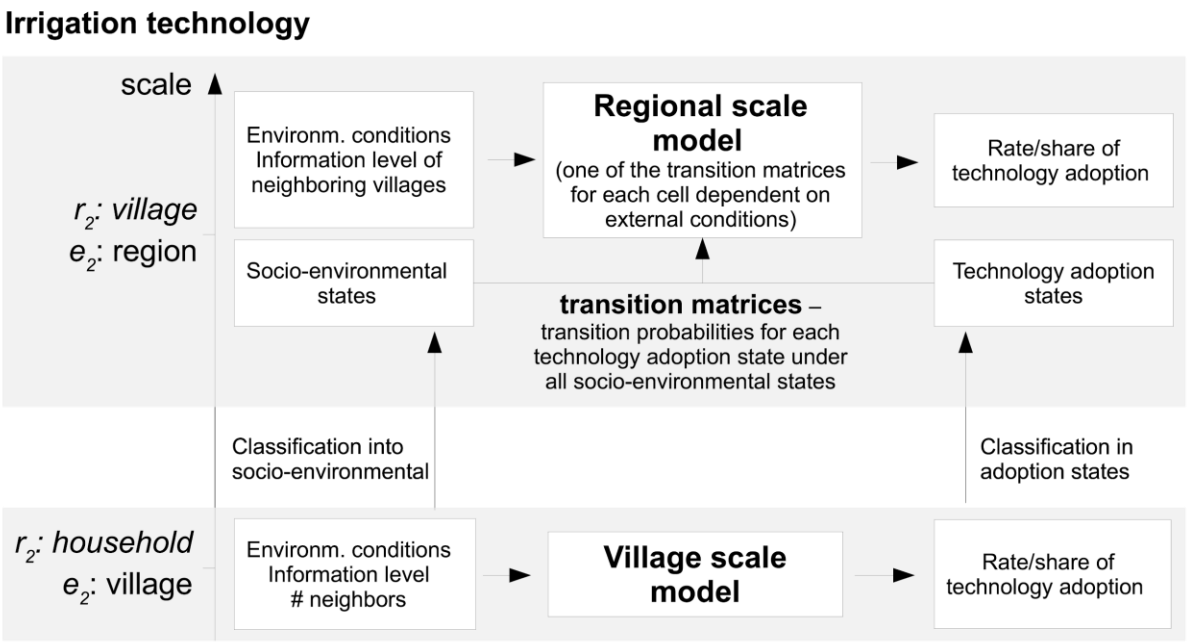

Figure S1: Application of the upscaling scheme to the hypothetical irrigation technology example.