In preparation for writing your RP- Malcomb et al (2014) discussion, please consider Tate's (2013) framework of vulnerability modeling and uncertainty and related debates.

Modelling Phase	Common Decisions	Malcomb et al (2014)
Model Structure	*Deductive* (based on theory) *Hierarchical* (deductive, organized by sub-themes) *Inductive* (based on data)	
Indicator Set (Hinkel 2011)	*Deductive* (theory-based) *Normative* (value judgements) *Inductive / statistical* (based on data characteristics *vis a vis* outcomes) *Non-substantial* (based on data characteristics alone) *Practical* (availability and cost)	
Analysis Scale	County Polygons Census Tract Polygons	
Measurement Error	Census Undercounts American Community Survey 90% Confidence Interval Margin of Error	
Transformation (often called normalization in cartography)	Totals or Counts Density Percentage Rate	

Normalization	Inversion
	 `1 / x` or `max - x`
	 min-max scaling
	 `(x – min) / (max – min)`
	 Z-score standardization
	 `(x – mean ) / stddev`	

Weighting	Normative Deductive Equal Weights Inductive / Statistical	
Aggregation	Additive (compensable/substitutable) Multiplicative / Geometric (interactive) Pareto ranking	
Uncertainty analysis Sensitivity analysis Validation (Rufat et al 2019)	Monte Carlo simulation Expert opinion Statistical test *vis a vis* outcomes	

Recalling our model for thinking about error, uncertainty, and ethics in spatial research…

1) Real World (Referent)
 	
2) Problem Conceptualization & Problem Framing
   a) Are you asking the right questions? Framing them the right way?
   b) Are the concepts & theories even appropriate?
 	
3) Construct Validity
   a) Referent – Symbol – Concept
   b) Applies to data representations and analytical models
 	
4) Error (Measurement / Representation)
   a) Accuracy vs Precision
   b) Location vs Attribute
 	
5) Error in Motion (Analysis)
   a) Propagation
   b) Uncertainty
   c) Sensitivity
 	
6) Ethics
   a) Should we be doing this research? How should we represent results?
   b) Participants, Audience, Responsibility
	Real World
	
	--- filter ---
	
	Conception
	
	--- filter ---
	
	Measurement & Representation
	
	--- filter ---
	
	Analysis
	
	--- filter ---
	
	Interpretation, validation

Can conducting **reproductions** (using the same data and techniques to attempt to produce the same outputs) help with vulnerability model uncertainty? How?

Can conducting **replications** (using new data & study contexts to test generalizability of the original study findings) help with vulnerability model uncertainty? How?

References

Hinkel, J. 2011. "Indicators of vulnerability and adaptive capacity": Towards a clarification of the science-policy interface. *Global Environmental Change* 21 (1):198–208.

Longley, P. A., M. F. Goodchild, D. J. Maguire, and D. W. Rhind. 2008. *Geographical information systems and science* 2nd ed. Chichester: Wiley.

Malcomb, D. W., E. A. Weaver, and A. R. Krakowka. 2014. Vulnerability modeling for sub-Saharan Africa: An operationalized approach in Malawi. *Applied Geography* 48:17–30.

Rufat, S., E. Tate, C. T. Emrich, and F. Antolini. 2019. How Valid Are Social Vulnerability Models? *Annals of the American Association of Geographers* 109 (4):1131–1153.

Tate, E. 2013. Uncertainty Analysis for a Social Vulnerability Index. *Annals of the Association of American Geographers* 103 (3):526–543.