Contribution ID: **25** Type: **not specified**

Flashpoints Signal Hidden Inherent Instabilities in Land Use Planning

Friday, June 16, 2023 5:00 PM (30 minutes)

Land-use decision-making processes have a long history of producing globally pervasive systemic equity and sustainability concerns. Quantitative, optimization-based planning approaches, e.g., Multi-Objective Land Allocation (MOLA), seemingly open the possibility to improve objectivity and transparency by explicitly evaluating planning priorities by land use type, amount, and location. Here, we show that optimization-based planning approaches with generic planning criteria generate a series of unstable "flashpoints"whereby tiny changes in planning priorities produce large-scale changes in the amount of land use by type. We give quantitative arguments that the flashpoints we uncover in MOLA models are examples of a more general family of instabilities that occur whenever planning accounts for factors that coordinate use on- and between-sites, regardless of whether these planning factors are formulated explicitly or implicitly. We show that instabilities lead to regions of ambiguity in land-use type that we term "gray areas". By directly mapping gray areas between flashpoints, we show that quantitative methods retain utility by reducing combinatorially large spaces of possible land-use patterns to a small, characteristic set that can engage stakeholders to arrive at more efficient and just outcomes.

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Session Classification: Mathematical Physics

Track Classification: Mathematical Physics