We are thankful to the Referee for providing meaningful and constructive feedback. We are hopeful that the amendments we offer in this round improve the quality and clarity of the manuscript.

Comment: 1. Although the authors review literature well in Section 2, it is difficult to know the current methods and protocols for treating disaster-related mental health problems. For example, what are the current standards and guidelines for allocating mental health clinicians and other resources following a disaster event? I expected to see this in Section 2.3, but this section describes methods for analyzing treatment measures rather than treatment options.

Reply: We agree that there could be more discussion involving current methods and protocols for post-disaster mental health treatment. The following will be added to section 2.3 at line 138 to add more clarity to this point.

Mental health care post-disaster is generally organized into three phases: early, intermediate, and long-term interventions (Hierholzer, Bellamy, and Mannix 2015). Early interventions range from Cognitive Behavioral Therapy to Psychological First Aid; intermediate interventions range from Classroom-Based Intervention to Specialized Crisis Counseling; while long-term interventions range from Cognitive Processing Therapy to Systematic Desensitization (Hierholzer, Bellamy, and Mannix 2015). Typically, these interventions will be performed by clinicians within medical facilities and shelters, while also facilitating community-based recovery to improve upon mental health resiliency in the event of future disasters ("Disaster Behavioral Health" 2020).

Cohen 2002 describes a similar approach in which treatment is distributed throughout three phases: impact, short-term, and long-term. Though different in name, these phases align similarly to those proposed by Hierholzer et al., 2015. However, Cohen 2002 introduces a new element in which treatment can target five levels of disaster-impacted individuals. Behavioral health needs post-disaster ranges from level one, primary survivors, to fifth-level victims. Primary survivors are those who experienced the disaster first-hand while fifth-level victims are those who experience some form of distress after learning about the event (Cohen 2002). Each of the five levels will have varying recovery needs that will impact clinician allocation. While it is important to consider the three phases of treatment post-disaster, it is also imperative to introduce preventative medicine as an opportunity to decrease the mental health impact of a disaster (Math et al. 2015). Preventative medicine manifests itself in terms of readiness in which training and equipping communities with mental health recovery tools prior to a disaster can improve the resilience of disaster-impacted individuals.

Comment: 2. The SVI is a composite index that combines multiple social and economic indicators to represent overall vulnerability. However, as the authors explain in Section 2.1, a tailored vulnerability based on a set of specific indicators would be more reasonable to model a specific type of mental health illness, patient, and hazard. This could also provide new options for decision-makers. Please elaborate on this point in the proper section.

Reply: Thank you for this opportunity to elaborate on this point. We will make these additions to the Discussion after lines 504-506: "The results of this simulation-optimization research show that it is possible to link social vulnerability with psychological impacts of disasters, and that through weighing tradeoffs in treatment options, decision-makers should be able to make efficient and informed resource allocation decisions."

Applying the SVI as an operationalized measure of social vulnerability provides decision-makers the capability to weigh treatment tradeoffs to make efficient and informed resource allocation decisions. Given that the SVI is a composite index of socio-economic indicators, decision-makers can distill the SVI's sub-components to tailor their mental health disaster response based upon specific mental health illnesses, patient vulnerability, and the experienced hazard. However, it is important to consider that social vulnerability describes complex relationships between demographic factors and that one factor alone may not necessarily cause that individual to be more vulnerable than another (Flanagan et al. 2011). Rather, it is the interactions between these factors that provide insight into a population's vulnerability to disaster-induced mental health illness (Cutter and Morath 2013). Furthermore, vulnerability can be introduced by the decision-makers themselves if their disaster planning and subsequent response fails to meet the needs of all populations within the community (Flanagan et al. 2011). However, decision-makers have the opportunity to account for the pitfalls of considering all or partial components of the SVI through coupled simulation-optimization outcomes.

Comment: 3. Lines 473-474: I think the baseline model needs to include clinicians to reflect the real world rather than the do-nothing approach. Could you include a baseline model that allocates clinicians according to the number of populations, and then compare it to the optimized results (i.e., Figure 5)? I believe this can better quantify the benefits of this approach.

Reply: We agree that the case study applied is an overestimate of clinician capacity as local-level resources are more likely to be drawn upon in response to disaster-induced mental health illnesses. We could not find New Orleans-specific clinician data and opted to use state-wide registered clinicians. However, the model could be easily modified to account for more representative clinician capacity if that data is known. With that said, we will add the overestimate of clinician capacity as a limitation to the study. Currently, the limitations account for a clinician treating patients in neighboring census tracts as well as a clinician's ability to only perform one-on-one treatment sessions. Including estimated clinician capacity will round out these limitations to improve the clarity in the methods upon which we chose to implement the case study.

Comment: 4. I recommend explaining additional input parameters, objectives, and constraints in the Limitations section. The current variables are sufficient for a proof-of-concept, but future research must address realistic factors. This could be related to the current standards and guidelines mentioned in my comment #1.

Reply: We agree that this is good discussion and will rework the third limitation, one-on-one treatment to address the limitations in model variables in general. Line 559.

The third limitation is in the model's consideration of input parameters, objectives, and constraints. The current instantiation suffices as a proof-of-concept; however, future iterations of the model must address realistic factors. For example, considering all state-registered psychologists and social workers as available to provide a generalized treatment with a fixed probability of success does not provide a meaningful decision aid. The parameters do not approach a true representation of reality and would thus present decision-makers an inaccurate estimation of community recovery. With that said, the simulation-optimization model provides the framework necessary to produce a more accurate decision aid. All that is required are inputs that approach the true representation of reality. Mental health disaster response protocols provide a wealth of possible treatments in all phases of recovery in addition to strategies improving mental health resilience. The model's outputs will converge on accurate representations of reality by considering all possible treatments in each stage of care as well as their efficacy in illness recovery. However, it is worth noting that as the complexity in the spatial-temporal relationships between treatments and resiliency is accounted for, the resulting model will also become increasingly complex. Future researchers must balance this complexity to provide the most accurate decision aid while maintaining usability for the decision-maker, avoiding the tipping point at which the model becomes too complex to be a useful disaster recovery tool.

Comment: Lines 66-67: "before constructing a model" is repeated.

Reply: Thank you for catching the duplication of this phrase. This will be fixed in the next revision.

Comment: Lines 379-381: Could you include population and SVI maps in the manuscript or supplement file? This will assist readers in identifying the optimal allocations spatially across socio-economic statuses.

Reply: Yes, we concur that this would ground the readers in an understanding of the population and vulnerability distributions across the area of study. This map will be added to line 381 which will provide an accompanying visualization for the statement of population and SVI minimum and maximum values.

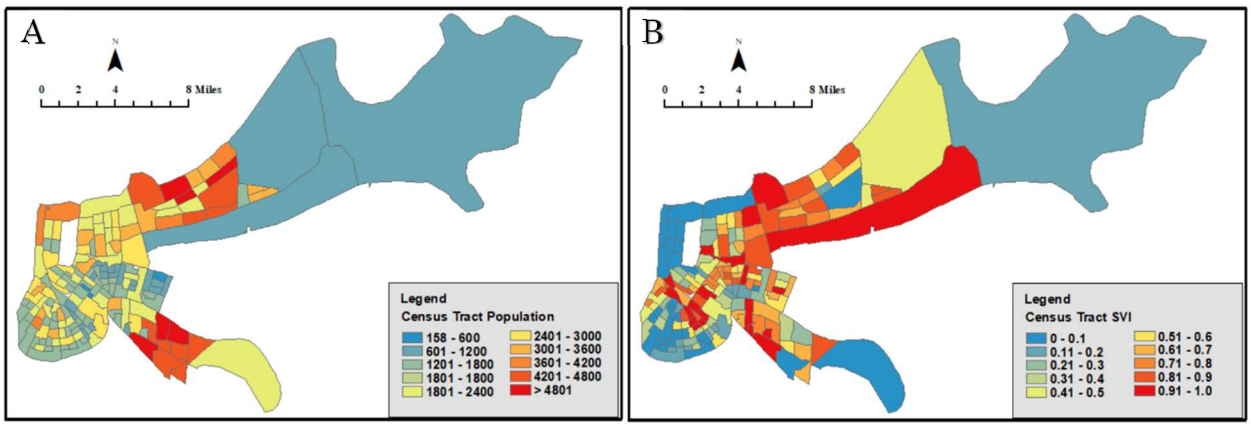

Figure 4: A) New Orleans population by census tract. B) New Orleans SVI scores by census tract.

Comment: Lines 230-245: Please provide references to support these sentences.

Reply: The content from these lines is original to the authors and describes the phased approach to the coupled simulation-optimization model as well as an example of how phase 1 can vary in implementation.

Comment: Equations (2-3) and (6-7): Please specify the subscripts "NT" and "T".

Reply: We agree that the current text lacks specification that those subscripts mean No Treatment (NT) and Treatment (T). Line 333-334 will now read: "Equation 2 provides the calculation for a census tract's MHS, given that no clinicians are allocated to conduct treatment (MHS_{NT}). Line 336 will now read: "Equation 3 provides a measure of how MHS improves with clinician allocation (MHS_T).

Comment: Equations (5 and 8): Please specify the subscript "j" and use "N" or "J" for all census tracts.

Reply: We agree that the variable descriptions are confusing. The description of j is in line 301 and we will make the edit to Line 349: "This becomes an index [0,1], where a value of zero represents a complete reduction of MHS across all census tracts (J), and a value of one indicates no improvement."

Equation 5 now reads: $MHSI = \frac{\sum_{j=1}^{J} MHS_{T,j}}{\sum_{j=1}^{J} MH_{NT,j}}$

Equation 8 now reads: $ELI = \frac{\sum_{j=1}^{J} EL_{T,j}}{\sum_{j=1}^{J} EL_{NT,j}}$

Comment: Please explain a potential application of agent-based modeling for clinician allocation, as a recent study does (Lines 205-206).

Reply: We agree that additional discussion of agent-based modeling provides a useful avenue for future work to explore. The following is additional discussion after Line 206:

Sun and Zhanmin 2020 describe that agent-based modeling can be used in the context of reinforcement learning where the agent's decision results in some reward which represents system improvement. Agent-based modeling provides an alternative approach to the simulation-optimization methodology proposed in this paper. In an agent-based modeling approach, clinicians would have the ability to choose which treatment to provide each patient, while the reward is the improvement, or degradation, of their mental health. The overall state of the system is then the quality of the community's mental health. The goal would remain the same: minimizing the mental health impact of the disaster. However, agent-based modeling would allow the clinicians to make treatment decisions and learn from the resulting mental health outcomes of those choices. This method could be increasingly useful as the complexity of the model also increases with the addition of more treatment options and treatment efficacy.

Comment: Given the frequency of natural disasters (e.g., hurricanes), the proposed approach can be applied to serial multi-hazard events. I recommend expanding on this benefit as well.

Reply: We agree that this is a good point to address in the discussion section. The following will be added to the discussion:

Though the proposed simulation-optimization framework was only utilized for a case study involving one disaster, its iterative approach provides the opportunity to account for serial multi-hazard events as well. Given the potential for prolonged disaster-induced mental health illness, individuals in the midst of recovery from one disaster may experience another disaster. The framework proposed in this paper provides an avenue to assess the cumulative effects of multi-hazard exposure on mental health. The multi-hazard use case provides additional support for the need to minimize the mental health illness outcomes post-disaster and facilitate rapid recovery prior to the next disaster.

Citations:

Hierholzer, Erik, Nikki Bellamy, and Brenda Mannix. 2015. "Disaster Technical Assistance Center Supplemental Research Bulletin: Disaster Behavioral Health Interventions Inventory." SAMHSA, May. https://www.samhsa.gov/sites/default/files/dtac/supplemental-research-bulletin-may-2015-disaster-behavioral-health-interventions.pdf.

"Disaster Behavioral Health." 2020. Public Health and Medical Emergency Support for a Nation Prepared, September. https://www.phe.gov/Preparedness/planning/abc/Pages/disaster-behavioral.aspx.

Cohen, Raquel. 2002. "Mental Health Services for Victims of Disasters." World Psychiatry 1 (3): 149–52.

Math, Suresh, Maria Nirmala, Sydney Moirangthem, and Naveen Kumar. 2015. "Disaster Management: Mental Health Perspective." Indian Journal of Psychological Medicine 37 (3): 261–71. https://dx.doi.org/10.4103%2F0253-7176.162915.

Cutter, Susan, and Daniel Morath. 2013. “The Evolution of the Social Vulnerability Index (SoVI).” United Nations University Press. http://collections.unu.edu/eserv/UNU:2880/n9789280812022_text.pdf.