Response to comments: Regional county-level housing inventory predictions and the effects on hurricane risk (nhess-2021-335)

RC2

General comments:

The authors implemented a neural network based model and simulated annual housing inventory changes. The modeling of inventory changes helps to better assess hurricane risks. The proposed methods have both academic and practical merits. The methodologies are well-documented and validated against benchmark models (a time-series and a linear regression model). The authors addressed a critical line of inquiries, particularly during the era of unpredictable climate change trends and vulnerable human society systems in response to external shocks. With these being said, a few comments below may help with the refinement of the manuscript and further progress to the next step.

> Thank you for your supportive comments. Our responses are provided below.

Line 35: It is interesting to state the current research gaps here concisely before jumping into contributions, which can provide research the context. The gaps and difficulties in employing an updated housing inventory into current risk assessment frameworks can be discussed in more details in the literature review section.

> We agree that it may be too early to state the contributions prior to discussing the research gaps, however we would prefer to contain the discussion about research gaps within the literature review section, rather than introducing research gaps in the introduction section. Therefore, we have changed line 35 to say:
>
> *"…paper has two outcomes. First, using…"*
>
> which allows us to set up the direction of the paper without getting in the weeds of the existing literature.

Line 40: This second contribution appears to be a little vague to me. In its current form, this statement sounds more like a methodological summary rather than a contribution highlight.

> We believe the usage of "outcomes" instead of "contributions" in line 35 resolves this issue.

Line 55: Please shorten the reviews of land use and change, which is less relevant to the article. Yet, you may want to expand Section 2.2, Housing economics. Various drivers of housing development should interest readers who want to learn more about forces underlying housing inventory changes.

We prefer to retain the land use and population projection literature section because most research that explores the interface of natural hazards and a changing built environment are rooted in the land use and population change modeling methods. In particular, we would like to retain the section that distinguishes machine-learning (ML) methods and cellular automata (CA) methods used in land change modeling because many of the natural hazard application studies use ML or CA methods. Additionally, the predictor variables listed in Table 1 represent drivers of housing development that we believe will interest readers who want to learn more about the forces underlying housing inventory changes.

Line 129: Why is county chosen as a unit of analysis (UOA)? How can your selection of UOA affect modeling outcomes? And is this unit applicable to other areas with different geographical and/or administrative context.

A sentence has been added at the beginning of Sect. 3 to clarify the choice of counties as the UOA. The revised section of Sect. 3 is provided below, where the additional sentence is highlighted.

"Modeling the annual changes in the number of housing units for 1,000 counties over a 10-, 20-, or 30-year time horizon requires a dataset of annual county-level data for more than 10 years for all counties in the study area. Counties were chosen as the unit of analysis, opposed to census tracts, block groups, or a grid cells, because county boundaries rarely change over a multi-decade period and data is available at the county-level over multiple decades for most of the predictors in Table 1. Of the 32 predictors identified as potential predictors of new housing construction, 25 (indicated by "2" in Table 1) had county-level data available for more than 10 years and were considered for this study."

Note also that the target variable is annual percent change in the number of housing units (as opposed to number of housing units), which reduces the effect of county size.

Any UOA can be utilized in different geographical and/or administrative contexts as long as there is annual data available for the 13 features in the REACH20 model between 1971 and 2019.

Line 142: Change the title to "model specifications"? Model types appears to be confusing.

We prefer to retain "Model types" as the header for Section 4. Linear, ARIMA, and LSTM models are distinctly different forecasting methods, i.e. model types. Modeling specifications sounds like it refers to specific instances of each model type.

Line 151. Maybe add an equation to define the mentioned model specifications

"y = mx + b" has been added to Line 153 to clarify the simple linear trend model type.

Line 170 through 175. Please cite references for these statements. And please use a chart or conceptual mathematical expression to illustrate how LSMT and neutral networks (in the context of housing change modeling) work. This may non-computer science experts better understand the concept.

Given that the paper is already very long, we purposefully provided three papers in line 178 for readers to reference if they are interested in learning more about the mechanics of LSTM models, rather than explaining the intricate inner workings of LSTM models.

Line 188: Please combine section 4 and 5 into a methods section. Currently, these two sections appear to be disconnected.

In our field, it is common to first present the modeling methods used in a general format (Section 4) before introducing the application of the modeling structure for our problem at-hand (Section 5). Therefore, we would prefer to retain a separation between these two sections. However, if the editor would like us to combine these two sections, we will do so.

Line 395: Figure 5 is too small.

Figure 5 has been adjusted to match the size of similar maps in Figures 7, 8, and 9.

Figure 10: Re-arrange sub-figures to make it easier to read x and y labels

Large labels have been added to the x- and y-axis of Figure 10 to make the information easier to read.