

FHFA List of Questions

I. Identifying and Assessing Climate and Natural Disaster Risk

1. How should FHFA define climate and natural disaster risk?

Natural disaster risk, from the perspective of the FHFA, should be defined as any hazard which can cause damage to a structure, its contents, and/or the perceived or actual value of the property. Hazards which may impact a property in this fashion include but are not limited to the following perils:

- Inland Flood (flooding due to precipitation)
- Nuisance Flooding (Also known as sunny day flooding which is caused by a combination of sea level rise and high tide)
- Tropical Cyclone Storm Surge
- Tropical Cyclone Wind
- Hail
- Tornado
- Straight Line Winds
- Extreme Heat/Drought
- Winter Storms (Freezing Temperatures, excessive snow, etc.)
- Wildfire
- Earthquake

All of the above natural hazards are affected by climate change with the possible exception of earthquakes. Climate risk should then be defined as the change in natural disaster risk by peril between the current climate and the same peril at a later date as modified by climate change. As an example, the financial loss to a structure for the current climate for inland flood may be 10% of the total value of the property whereas the future percent loss in the year 2050 may be 20%. Climate risk could then be defined using the relativity between the current and future risk.

2. What are the climate and natural disaster risks to the regulated entities, including long- and short-term risks, and how might such risks change over time? To what extent, if any, could such risks now or in the future impede the ability of each regulated entity to operate in a safe and sound manner, fulfill its statutory mission, or foster liquid, efficient, competitive, and resilient national housing finance markets?

The perils mentioned in question 1 should be included in the list of long and short term natural disaster risks. Each natural disaster risk has the ability to cause material damage and thus a dollar cost to an individual property or series of properties. In addition to the direct dollar cost for a given peril, the perception of value for a location is likely to be negatively affected in areas of high and/or increasing hazard. This decrease in perceived value may come from areas where the public generally knows hazards are increasing, from public/private maps or reports, or from the insurance industry which tracks climate risk very closely and will likely increase rates in areas of high and/or increasing hazard. It is important to also note that climate change may have only modest effects in the next 5 to 10 years, however at the 20 to 30 year time horizon many perils are expected to see material changes. These changes have implications for portfolios held over a longer period, most notable pension/investment funds, mortgages, and other insurance linked securities.

Risks may be exacerbated by any number of shifting climate variables which are expanded upon below:

- Inland Flood
 - Inland flooding is expected to increase in intensity in the US due to increases in temperature and consequently increases in available atmospheric moisture. While it is generally expected that climate change will cause more extreme precipitation events, it is not well understood if the frequency of events, which include large and small events, will increase as a whole. Overall, models suggest the annual average loss due to flood will increase non-uniformly over the entire US. Additionally, inland flooding caused by hurricane induced precipitation is expected to increase in intensity as storms slow down due to shifting atmospheric patterns.
- Nuisance Flooding
 - Nuisance Flooding is caused by oceanic water inundating populated areas during normal tidal cycles. As sea level increases due to climate change, tides have been reported as causing repetitive damage to homes and structures near the coast. As sea level rise continues to increase across the Atlantic and Pacific coasts, nuisance flooding events will increase in both affected area and magnitude.
- Tropical Cyclone Storm Surge
 - Tropical cyclone storm surge events are expected to increase in frequency, affected area, and magnitude due to shifting atmospheric patterns and global sea level rise. As mean sea level increases, smaller hurricanes which may not have breached existing sea walls and other oceanic defenses will begin to do so,

causing more frequent small scale surge losses. The lower frequency higher magnitude events will also see an increase in severity from higher sea levels causing surge events to penetrate further inland.

- Tropical Cyclone Wind
 - Increasing sea surface and atmospheric temperatures are projected to alter the relative proportion of Category 1-5 tropical cyclones, leading to a general increase hurricane wind magnitude.
- Hail/Tornado/Straight Line Winds
 - Changes in atmospheric patterns are expected to both shift and expand the affected area where these hazards are most prevalent. There is emerging scientific evidence that the frequency of severe convective storms may increase, however this is less certain at this time.
- Extreme Heat
 - Droughts and extreme heat events are expected to increase both in frequency and magnitude due to increasing temperature and shifting atmospheric patterns. These heat events may cause loss of life, strains on local power infrastructure, and decreases in agricultural yield for most crops.
- Winter Storms (Freezing Temperatures, excessive snow, etc.)
 - Winter storms are expected to increase in magnitude and potentially in frequency. Although increasing temperatures are generally thought to be deleterious to winter storms rates and intensity, the increased atmospheric moisture from increased temperatures will provide additional fuel and increase precipitation rates, increasing the overall magnitude of these events. Additionally, ice events are also expected to increase in frequency as increased temperatures increase the likelihood of freezing rain and icing.
- Wildfire
 - Wildfire is expected to increase in frequency, affected area and magnitude due to increasing temperatures and shifting climate patterns. As droughts become more common over a wider area, wildfires will see significant increases.
- Earthquake
 - There is some indication that changes in surface pressure can increase the likelihood of earthquakes, however the impact of atmospheric variables and parameters such as groundwater on earthquakes is still an active area of study.

3. What methodologies, datasets, variables, assumptions, future climate scenarios, and measurement tools are used to measure and monitor climate risk to the national housing finance markets?

Describe any gaps in available data that limit the ability to measure such risks. How could such data gaps be resolved?

Much of the necessary data to estimate future climate risk to existing portfolios of business are already available in the market. The International Panel on Climate Change (IPCC), an entity of the United Nations, has been releasing reports collating and reporting peer reviewed state-of-the-"climate"-science, providing a detailed and thorough assessment of past, present,

and future climate KatRisk uses data as reported from the IPCC as well as from respectable governmental organizations such as the National Oceanic and Atmospheric Administration (NOAA) in order to provide estimates of climate impact for Inland Flooding, Storm Surge and hurricane induced Wind. The KatRisk model provides losses due to current climate and losses due to many different climate states at various time horizons in 10 year increments from 2020 to 2100. Loss parameters include average annual loss and exceedance probability curves which are used commonly in the actuarial and statistics community. These curves quantify risk to various single and grouped risks (portfolios of business) for a given hazard or grouping of correlated/anticorrelated hazards.

4. What risk management strategies or approaches—including but not limited to those related to pricing, insurance, credit risk transfers (CRT), loss mitigation, and disaster response—do industry participants use to address climate and natural disaster risk?

The insurance and insurance linked security industries have been studying climate change for some time. In many ways, they have led the financial industry in general preparedness, awareness and the understanding of the potential cost of natural disaster/climate risk due to various hazards. Current climate risk for atmospheric perils has been generally understood since the 1980/1990s, the catalyst being the advent of Catastrophe Models. These models simulate possible future events (e.g., hail, hurricane, inland flood) and generate tens of thousands of years worth of possible events in order to provide clients with information about the magnitude, frequency, and correlation of every possible event that could impact a portfolio of business, particularly as it pertains to the damage to buildings and their contents. These simulations are then run through loss models which provide the user with loss statistics vital for appropriately pricing insurance policies. It is useful to think of catastrophe model output as a simulated loss history. Traditionally, actuaries are able to price and appropriately value the risk of a natural hazard to a property by reviewing past loss history. Many areas, however, have a limited loss history for a particular hazard and catastrophe models are used to fill those gaps and account for unknowns such as how rapid construction in and around a city affects that city's risk profile. Climate change considerations are then the newest feature in these catastrophe models that allow the leveraging of information from scientific sources (e.g., the IPCC) to inform and modify existing catastrophe model hazard parameters to provide risk and loss information considering future climate states.

5. How, if at all, should FHFA incorporate into its assessment of the regulated entities' climate and natural disaster risk the potential for abrupt repricing of real estate properties exposed to acute natural hazards?

KatRisk suggests the use of catastrophe models to provide a simulated loss history in current and future climate states as well as actuarial/statistical models to provide a simulated probability of default on existing mortgages and mortgage portfolios. This sort of study has been done by KatRisk and an actuarial partner (Milliman) as funded by the Society of Actuaries (SOA) in 2020 and is available for review. A link will be provided in question (6) below. From a qualitative perspective, joining catastrophe, climate, and actuarial/statistical models allows the

use of information such as the total value of a mortgage, the remaining value of a mortgage, the financial status of the borrower, any building insurance policies, and statistics on the mortgaged building's structural characteristics. The above information is then evaluated on an event by event basis to compute, for a given event level loss, the probability of the borrower defaulting on their loan due to excessive or repetitive losses.

6. With respect to the foregoing questions, FHFA invites interested parties to submit any studies, research, data, or other qualitative or quantitative information that supports a commenter's response or is otherwise relevant to the regulated entities' climate and natural disaster risk.

Residential Flood Risk in the United States: Quantifying Flood Losses, Mortgage Risk and Sea Level Rise:

<https://www.soa.org/globalassets/assets/files/resources/research-report/2020/soa-flood-report.pdf>

II. Enhancing FHFA's Supervisory and Regulatory Framework

7. How should FHFA evaluate the adequacy of a regulated entity's ability to assess and manage the impacts of climate and natural disaster

KatRisk suggests that portfolios of properties be run through existing Catastrophe Models, as explained above, and that the output of those models are then evaluated by actuaries to determine the probability of default for each property. This analysis should then be performed at various future time horizon's using climate states within the catastrophe models to determine the relationship between % value defaulted and year. The number of future time horizons for a portfolio of mortgages is determined by the mortgage with the longest remaining payment years. The integrated percent of defaulting mortgages over the entire portfolio can then be tied to a lettering system similar to how the insurance industry is regulated for solvency by rating agencies (AM Best, Fitch, Moody's etc). KatRisk would suggest speaking to other outside entities for more detailed suggestions on setting thresholds and determining an appropriate rating system.

8. What specific processes and systems of a regulated entity should FHFA examine in its supervision of the regulated entities' climate and natural disaster risk management?

The FHFA must review and/or mandate which models are appropriate and fit for purpose for this type of assessment. This includes the catastrophe models themselves and the actuarial approach for computing the various risk parameters discussed above. Future climate states must also be rooted in peer reviewed science with specific scenarios selected for evaluation at each time horizon. For example, there are several climate scenarios as reported by the IPCC which are reflectant of differing emissions scenarios, known as Representative Concentration Pathways or RCPs. The FHFA would need to mandate appropriate RCP scenarios for each



year using scientific resources which could include companies such as KatRisk. The above then ensures a consistent rating for every portfolio of business evaluated.

9. How should FHFA prioritize the various climate and natural disaster risks to the regulated entities?

KatRisk would suggest looking at the least insured and highest risk hazards first, which include hurricane induced wind and storm surge, as well as inland flooding. Even looking at portfolios of business as they stand today, before climate change, there is likely a lot to be learned and many portfolios likely have an unacknowledged risk due to a natural catastrophe. The inland flood peril has the added danger of oftentimes being underinsured or uninsured, especially when buildings are outside of the Special Flood Hazard Areas (SFHA) and therefore typically not insured by the National Flood Insurance Program (NFIP). While private flood insurance is a growing business, there is a long acknowledged protection gap that still exists and is slowly narrowing, but the slow pace leaves flood portfolios of business susceptible to significant financial loss. After Inland Flood, risks such as wildfire, hail, severe convective storm, straight line winds, and extreme temperatures should then be evaluated. Many of the above hazards are fairly well insured and therefore less at risk, however, climate change may significantly affect the expected risk as mentioned in question (2) above.

10. Some government programs and interventions that mitigate disaster-related credit losses at the regulated entities are not available to all mortgage market participants and may not be available to the regulated entities in the future. How, if at all, should FHFA consider current risk mitigants and their uncertain future availability in its supervision and regulation of each regulated entity's management of climate and natural disaster risk?

Catastrophe models have the ability to run portfolios with different defense measures and different insurance terms if, say, the NFIP were to no longer provide insurance. Otherwise, KatRisk has no expertise to answer this question.

11. What risks to the regulated entities' critical service providers and other third parties—including but not limited to mortgage servicers and insurers—should FHFA consider when assessing each regulated entity's management of climate and natural disaster risk?

KatRisk has no expertise to answer this question.

12. What differences between the Enterprises and the FHLBanks should FHFA consider in tailoring its supervision and regulation of each regulated entity's management of climate and natural disaster risk?

KatRisk has no expertise to answer this question.

13. Should FHFA implement a stress testing, scenario analysis, or similar program to assess the regulated entities' climate and natural disaster risk? If so, what factors should FHFA consider in defining the purposes, design, and scenarios of any such programs?

From the perspective of evaluating natural disaster risk for both current and future climate states, KatRisk would suggest running models with and without climate change as described in (8) above. Additionally, it is possible to run portfolios against select past events, such as hurricane Harvey. With the help of an actuarial firm, some probability of default due to these specific events could then be determined, augmenting the computation of the rating schemes mentioned in (7) above. In general however, there will never be enough historic events to evaluate every building in the US, therefore simulated return period events may become very useful for each portfolio of business. Catastrophe models can easily compute the simulated loss associated with an event at any return period. As an example, a user could extract the loss for a portfolio of business's 1 in 100 year return period event where a 1 in 100 year return period event is equivalent to an event with a 1% probability of meeting or exceeding the stated loss. Return period portfolio loss is a common required output for insurance rating agencies to determine solvency ratings.

14. Are there alternative risk mitigation strategies, including but not limited to insurance or insurance-based financial instruments, that could transfer risk from the regulated entities' portfolios or products or assist with the market pricing of climate and natural disaster risks?

Yes, as mentioned in several of the above questions, insurance should be considered as a mitigation strategy when evaluating portfolios of business. Additionally, some communities may alter physical defenses or change building materials requirements which changes the risk profile of a structure. Catastrophe models are built to incorporate such changes as long as the user can provide the likely parameters (i.e. a building being elevated on stilts, etc).

15. How might the regulated entities support their housing finance missions while minimizing the impact of climate and natural disaster risk?

KatRisk believes that understanding risk is an integral step toward proper financial portfolio management and would suggest using the above mentioned models to better own and manage that risk. Regulated entities can assist this process by coming up with common questionnaire and rating equations that can be used by all holders of building risk. This regulation will then require that institutions evaluate, learn what their true natural disaster and climate risks are, and quantify the risk. Without a regulatory requirement, it is difficult to see widespread interest in learning more about hazard risk in some segments of the financial industry.

16. Market discipline could potentially supplement FHFA's supervision and regulation of the regulated entities' climate and natural disaster risk appetite and management. Market discipline depends in part on the information that is available to shareholders, creditors, and other counterparties. Is the existing publicly available information sufficient for shareholders, creditors, CRT and other investors, and other counterparties to understand and exercise market discipline over a regulated entity's appetite for and management of climate and natural disaster risk? If not, what changes are needed? Should each regulated entity be required to disclose additional information, including but not limited to the extent to which its underwriting practices take into account climate and natural disaster risk?

As climate change serves to increase the financial impact of natural catastrophes, the past will no longer be a good indicator of the future. This is where scientific models must become a part of the conversation above and beyond what is available for public access or available to each institution as part of its recorded loss history. Catastrophe models have over 30 years of development and experience in answering these types of questions and should be leveraged for determining financial risk for a portfolio of business, both due to hazards in current and future conditions. KatRisk would suggest the disclosure of specific information to trusted rating agencies which could then issue a consistent, well understood and well supported rating.

17. What, if any, additional periodic or episodic reporting requirements for the regulated entities should FHFA consider to improve the publicly available information on the regulated entities' management of climate and natural disaster risk?

KatRisk would suggest publicly available letter ratings similar to the insurance industry as discussed above. These ratings would take into account current and future climate. If an institution only held, as an example, a book of 10 year mortgages vs. a book of 30 year mortgages, the later would potentially hold a lower rating unless the mortgage was well insured or had other planned hazard loss mitigations planned.

18. Policies to manage climate and natural disaster risk could increase the cost of housing, making it more difficult for lower income households in some areas to obtain affordable housing. Are there policies the regulated entities could pursue to mitigate such adverse effects for lower income households in vulnerable areas without undermining efforts to manage climate and natural disaster risk?

While KatRisk believes this is an incredibly important question, we are not sufficiently knowledgeable to provide a response. A large portion of future climate change risk can be mitigated, with improvements in building materials and defensive measures, such as dams and levees, as an example of a applicable strategies. The impact of these mitigation efforts can be modeled by companies like KatRisk within a catastrophe model. How these defensive/mitigation measures are funded from a policy perspective, however, is outside of KatRisks expertise.

19. Minority borrowers exhibit higher rates of delinquencies for longer durations following natural disasters. Are there policies the regulated entities could pursue to mitigate such adverse effects for minority borrowers exposed to climate and natural disaster risk?

While KatRisk believes this is an incredibly important question, we are not sufficiently knowledgeable to respond.

20. What type of organizational structures should FHFA and the regulated entities consider adopting for themselves to support the management of climate and natural disaster risk?

KatRisk has no expertise to answer this question.

21. What specific issues or topics should FHFA consider for future research on climate and natural disaster risk to the regulated entities and the national housing finance markets?

KatRisk would suggest funding studies using a catastrophe modeller like KatRisk in conjunction with an actuarial firm to expand and run additional studies such as was performed within the SOA paper mentioned above in questions (5-6). Studies like this should be expanded to include banks and other financial institutions that would be affected by said regulation to ensure that the study addresses the appropriate questions and provides realistic solutions. The FHFA should also directly be involved in these studies to ensure a fair, balanced and scientifically rigorous report is generated.

22. What data or housing market information would be beneficial for FHFA to make available, to the extent permitted by privacy considerations, to researchers and other interested parties to support the assessment of climate and natural disaster risk to the regulated entities or the national housing finance markets?

Past delinquency/default data would be useful with as much appropriate metadata as possible. For hazards such as flood, location is incredibly important -- generally the road in front of a house floods much more readily than the house itself. This means that accurate latitude and longitude information would be appropriate for these studies to ensure the modeler is able to evaluate the risk at the rooftop location, not within, say 50 meters of the rooftop. Any other deleterious financial effects due to natural hazards would also be useful to ensure that the industry is evaluating not just mortgage risk due to the above mentioned natural disasters, but any other event which should be modeled.

23. What factors should FHFA consider in determining whether to formally participate in or informally partner with organizations or groups focused on climate and natural disaster risk management?

As a potential organization focused on climate and natural disaster risk management, KatRisk does not feel it appropriate to advise on this question, but would suggest speaking to any potential partner's clients to evaluate said organization before deciding to partner with them.

For flood catastrophe models, an intermodel comparison was performed in 2017 by an insurance company named Argo which is useful in learning how one could evaluate a catastrophe model (<https://www.argolimited.com/flood-model-showcase/?locale=en>).

24. Are there existing or potential government agencies or programs that FHFA could partner with to enhance the Agency's supervision and regulation of climate and natural disaster risk to the regulated entities?

KatRisk would suggest partnering with the Federal Emergency Management Agency (FEMA) through the group responsible for the maintenance and updating of the NFIP. They have a very strong knowledge base in modeling flood using both catastrophe models and other methods used in the past.

25. What, if any, other enhancements should FHFA consider to its supervision and regulation of each regulated entity's management of climate and natural disaster risk? Other enhancements could include but need not be limited to: (i) regulatory capital requirements or other loss-absorbing capacity requirements that ensure each regulated entity has the capacity to absorb impacts of climate and natural disaster risk; (ii) disclosure requirements to provide shareholders, creditors, CRT or other investors, and other counterparties with appropriate information about a regulated entity's climate and natural disaster risk; and (iii) changes to FHFA's supervisory program to enhance examination of or reporting on each regulated entity's infrastructure and processes for identifying, assessing, mitigating, and monitoring the regulated entity's management of climate and natural disaster risk.

KatRisk would suggest looking into regulation regarding construction materials and methodologies as well as the construction of defensive structures (sea walls, levees, etc). There has been ongoing discussion about communities in flood prone areas adding defensive structures which are largely funded by reductions in insurance premiums from the mitigation effort. KatRisk is not aware of any communities that have moved forward with this type of mitigation/cost offset plan, however it does sound like a viable solution. KatRisk is not sufficiently knowledgeable to assert how any such plan mentioned above could be implemented, funded, or how requiring such measures could affect the financial industry.

26. To what extent, if any, should FHFA support efforts to develop standards of classification and data reporting on climate and natural disaster risk to the financial performance of companies, such as those by the Sustainability Accounting Standards Board, domestic and foreign government agencies, or others?

KatRisk supports generating common standards and classifications as mentioned above with regards to the establishment of a rating system.



About KatRisk

KatRisk is an independently owned catastrophe modelling business formed in 2012. We have three offices, two in the US and one in Germany with a combined > 100 years of catastrophe modelling experience.

We service clients ranging in size from multinational industry leaders to super regional specialty carriers primarily within the insurance and financial services industries including:

- Four of the largest 5 worldwide reinsurance brokers.
- Three of the top four worldwide non-life reinsurers.
- Four of the top 15 worldwide property insurers.
- The United States Federal Emergency Management Agency (FEMA).
- The Philippines Government
- Total clients: >50

For additional information, please contact Brandon Katz at KatRisk LLC (Brandon.Katz@KatRisk.com)