2023 COASTAL MASTER PLAN

PM-TAC MEETING REPORTS

SUPPLEMENTAL MATERIAL C1.1

REPORT: VERSION 02
DATE: APRIL 2023

COASTAL PROTECTION AND
RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802
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COASTAL PROTECTION AND RESTORATION AUTHORITY

This document was developed in support of the 2023 Coastal Master Plan being prepared by the Coastal Protection and Restoration Authority (CPRA). CPRA was established by the Louisiana Legislature in response to Hurricanes Katrina and Rita through Act 8 of the First Extraordinary Session of 2005. Act 8 of the First Extraordinary Session of 2005 expanded the membership, duties, and responsibilities of CPRA and charged the new authority to develop and implement a comprehensive coastal protection plan, consisting of a master plan (revised every six years) and annual plans. CPRA's mandate is to develop, implement, and enforce a comprehensive coastal protection and restoration master plan.

CITATION

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ACKNOWLEDGEMENTS

This document was developed as part of a broader Model Improvement Plan in support of the 2023 Coastal Master Plan under the guidance of the Modeling Decision Team:

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- University of New Orleans – Denise Reed

INTRODUCTION

The Predictive Models Technical Advisory Committee (PM-TAC) for Louisiana's 2023 Coastal Master Plan was formed in 2019 to provide input on the use of models throughout the development of the 2023 Coastal Master Plan. The purpose of the PM-TAC is to provide CPRA with 'over the shoulder' working-level guidance and recommendations to a team of scientists, engineers, and planners to improve the modeling tools used for the 2023 Coastal Master Plan analysis. This committee is convened to work directly with the modeling teams to help resolve technical issues at hand and provide input, feedback, and recommendations throughout the model improvement process. The following pages detail the PM-TAC meeting reports.

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PM-TAC REPORT #1

DATE: 2019-08-08

RE: PREDICTIVE MODELS TECHNICAL ADVISORY COMMITTEE (PM-TAC) – AUGUST 2019 MEETING REPORT

PM-TAC MEMBERS

- Jen Irish - Virginia Tech, Department of Civil and Environmental Engineering
- Sam Brody - Texas A&M, Department of Marine Sciences
- Courtney Harris - Virginia Institute of Marine Science, Department of Physical Sciences
- Wim Kimmerer - San Francisco State, Estuary and Ocean Science Center
- Matt Kirwan - Virginia Institute of Marine Science, Department of Physical Sciences
- Mark Stacey - UC Berkeley, Department of Civil and Environmental Engineering

SUMMARY POINTS

OVERALL COMMENTS FROM PM-TAC

- Overall this is an impressive and ambitious effort, and the comprehensive approach CPRA is taking is appreciated.
- The modeling team has done a great job in the past and continues to do so. The cohesion, flexibility, and capabilities of the modeling team are impressive. Moreover, they seemed very receptive to our suggestions.
- The format and content of the meeting on August 8, 2019 was excellent. CPRA did a great job of identifying points on which the PM-TAC can give input, and provided necessary background and framing for the PM-TAC to be effective.
- The Master Plan sequence and modeling process is set up in a way to encourage progress on long-term model development between master plan publication dates,

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while enforcing completion of intermediate steps for each version of the plan.
- CPRA did a good job of taking the comments from the previous PM-TAC and implementing changes.
- A few of the focus questions ask if something is "sufficient" (an approach, etc.), but sufficient for what? Difficult to answer.

INTEGRATED COMPARTMENT MODEL (ICM) UNCERTAINTY ANALYSIS

GENERAL COMMENTS

- For the 2017 Coastal Master Plan, CPRA has done a good job of characterizing uncertainty associated with the ICM via a sensitivity analysis approach, in particular in identifying the primary parameters contributing to uncertainty and in analyzing spatial patterns in uncertainty in land-building.
- Maps of uncertainty results (versus time series graphs) are most helpful.
- It is important to develop an approach for carrying uncertainty through to surge/flooding and risk analyses. It is also important to consider uncertainty in performance and outcomes of the projects as part of the analysis.
- Consider how to incorporate other uncertainties, e.g., land use and future development?
- The focus on total land area does not distinguish that some land may be more valuable (ecologically, economically, socially, etc.) than other land.
- The total land area is extremely sensitive to sea level rise (SLR), which acts as an external driver for much of the system (e.g., habitat types, community response). Continue to focus the uncertainty analysis on factors where there may be some local control on uncertainty either through improved field measurements, or model developments, or projects.
- While the focus on land area for the analysis is a metric that can be mapped, it leaves out other metrics (for example, habitat types and community response) also influenced by SLR. It is noteworthy, however, that the simplicity of focusing on land area distills master plan results to an easily and universally understood metric.
- SLR uncertainty (in scenarios) is so big on the plots presented that it drowns out the influence of other factors.
- The two strongest factors in the uncertainty (annual water level and organic accretion) are directly related to the two strongest forcing (sea level rise and subsidence); it is probably best to communicate these as uncertainties in sea level and net subsidence (rather than as differently named variables).
- Was there thought given to just showing loss of land, vs. net?
- An uncertainty analysis is based on some assumptions regarding the sources of uncertainty. Be clear in communicating what the uncertainty analyses incorporates.
- Using an ensemble approach for the uncertainty analysis would be the ideal, varying the most sensitive parameters. However, it is recognized that such an approach may

be computationally prohibitive for the 2023 plan; but, such an approach may be suitable as a long-term goal for future plans.
- Do not try to include every potential source of uncertainty in the uncertainty analysis; model as little as needed, as well as you can, for the given task.

FOCUS QUESTION

Is the approach used for 2017 (focused on land area) sufficient to evaluate uncertainty for 2023? What should we consider adding to the analysis (e.g., extending the work to the Habitat Suitability Indices (HSIs))?

- Think beyond land area because when focusing on land area, the water level and organic accretion become the two most important factors. For example, if the focus is on habitat, salinity is also important.
- Linking HSI with modeling predictions for environmental conditions and uncertainty would be a big step.
- HSIs: It would be useful to carry uncertainty forward into model predictions.

DEVELOPMENT OF ENVIRONMENTAL SCENARIOS

GENERAL COMMENTS

- The overall approach and timeline laid out by CPRA for developing the environmental scenarios was sound, defensible, and comprehensive. It is suggested that CPRA additionally consider:
    - Including human activities into the environmental scenarios.
    - Incorporating precipitation and land use that affects the rainfall: flow relationship into the future conditions.

FOCUS QUESTION

Our proposed approach for adjusting most environmental variables (e.g., precipitation, water temperature, etc.) will use anomalies being developed for the 6th Assessment Report of the Intergovernmental Panel on Climate Change (AR6). If those data are not available in time for scenario development, what is the best back up plan? Would data from previous efforts be sufficient? Are there other data sets to consider?

What is the best option to adjust flows for future conditions (50 years)?

1. anomalies on rainfall,
2. anomalies on flow,
3. ensemble daily mean time series for flow?

- Scenarios for storm sequencing would be worth adding to the analysis.
- As long as it is clear what the cutoff date for incorporating new data/information into

the scenarios is, it is reasonable that not all new information will be able to be included. However, if new information becomes available that is very different compared to what was used, be prepared to address and talk about that.

- Long-term changes in features of the human-built environment will interact with precipitation projections to define future runoff – be aware of this in applying anomalies.

MODELING STORMS IN THE ICM

GENERAL COMMENTS

- It is useful to revisit the approach used to represent storms while developing the 2023 master plan. Option 2 strikes the right balance between robustness and efficiency for the purposes of master planning.
- For Option 3, there were concerns regarding the sediment budget being realistic since the forcing is applied coast wide; this is something that CPRA needs to think about and evaluate.
- Option 4: It is recognized that the computational burden of Option 4 as presented is not feasible within the 2023 master planning timeline, but such an approach should be considered in future plans. As an interim step, is it possible to use a lower fidelity modeling suite with a lower resolution in ADCIRC, other models? Would that make Option 4 more feasible? Lower fidelity brings larger errors, but it would allow the many more simulations needed for an ensemble approach.

FOCUS QUESTION

Based on the options presented and information regarding localized storm effects in 2017, do the new options (i.e., 2-4) appear feasible, are they likely to provide substantial improvement in considering storm effects on the landscape commensurate with the development/computational effort they entail?

- There was general consensus that Option 2 is the favored approach.
    - Two members did not have strong opinions between Options 1 and 2
    - Option 2 seems a little more focused on the impacts that are important.
- Thinking long term (beyond the 2023 plan), Option 4 is an approach that CPRA should strive towards (though the challenges with this approach were recognized).
- While a full ensemble approach is not feasible for the 2023 Coastal Master Plan, could CPRA do 3 to 4 sequences that are distinctly different from each other? If those are randomly selected, it could be helpful to see which projects are the most robust.
    - CPRA could use the Option 2 approach and use different storms to generate sequences in space and time to run on the future without-action scenario to see what the differences are and if there are effects on the landscape (flood hazard and risk). If there are no significant differences, then that provides evidence that the storms selected, and their sequencing, do not matter.

- Should also explore the probability distributions of different storm events for particular segments of the coast, and investigate consequences for those segments. This analysis could be used to assess the likelihood of persistence of projects undertaken in those segments.
- Could look at projects that fell in between those that performed really well and those that did poorly to see if any projects were given the benefit of the doubt because of the specific storms that were run.

ICM-BARRIER ISLAND TEAM RECOMMENDATIONS

GENERAL COMMENTS

- Pleased to see the move from 2017 BIMODE to the planned Phase I; this is a real improvement in the treatment of barrier islands.
    - This modeling strategy shift gets rid of a lot of discontinuities that emerge in the 2017 analysis, and will lead to more realistic communication between cross-shore profiles.
    - Primary benefits of this modeling change are the integration of cross-shore and longshore sediment fluxes.
- Vegetation model on back barrier can be improved by including that zone in LAVegMod for organic response, but have mineral accretion be informed by overwash from BIMODE.
- Detailed modeling options (e.g., XBEACH, etc.) generally operate on a single storm event – therefore not useful for the MP framework because they are very computationally expensive.
- The feedback (or lack of) between the barrier island and hydro model is important. Asymmetric partitioning makes a lot of sense.
- The barrier island (BI) model will need to periodically check in with ICM-Hydro inlet sizes to ensure that the two models are 'seeing' the same inlet size. Additionally, any breaching or inlet sizes calculated from the profile/longshore equations in the BI model will need to feedback into ICM-Hydro.
- Advantage of Phase 2 vs. 1 – is it worth the added investment?
    - Phase 2 allows you to evolve outside of historical conditions.
    - Does forcing outside of historical conditions matter in the computations of surge and wind waves? A sensitivity to the range of possible futures would allow this to be tested.
    - Phase 2 takes SLR into consideration and may increase retreat rate.
    - Has explicit storms.
- There is the assumption that barrier islands are maintained/repaired following events, but the mechanism and timeframe for how that occurs is uncertain. Perhaps there should be some modification in what is handed off to the hydro model following storm events to account for barrier islands not being immediately maintained (e.g., increased salinity intrusion could persist for months or over a year depending on

what assumptions are made).
    - Worth thinking about testing scenarios for management interventions.

FOCUS QUESTION

Given the assumption that barrier island integrity will be maintained in the future (i.e., breaches will be filled in), does the Phase 1 approach provide CPRA with a reasonable way of estimating future barrier shoreline change? Are there improvements to the proposed Phase 1 approach that could be made with the time available? Or are there ways of streamlining the Phase 2 approach such that it might be usable more quickly?

- It is essential that Phase 1 is finished by July 2020 and that the Phase 1 effort is not derailed. The question is about how much to invest in the Phase 2 approach. It is suggested to have some researchers work on a relatively small scale Phase 2 "pilot project," which could be completed in relatively short time, and then its results compared to the Phase 1 results from the same area.

ICM-HSI TEAM RECOMMENDATIONS

GENERAL COMMENTS

- The modeling team has done a good job of exploring alternative ways of turning data on catches of various fish and shrimp species into HSIs. The modeling team is aware that this process has a number of limitations, and that the measured attributes of (physical) habitat are necessary but far from sufficient predictors of actual occurrence.
    - For example, there are many examples in the literature showing the occurrence of organisms outside of their usual habitat or their absence inside, as a result of food availability, predation risk, and other factors (often not measured). This argues for circumspection in making predictions using the HSIs.
- Collinearity is not a problem unless trying to split apart the effects of salinity versus temperature. If you care about how much of the response is due to salinity versus temperature, then you could do principal component analysis to evaluate individual effects and you will get the same fit as if original data were used.
- Discussed the option of expanding the data set beyond LDWF data to include CRMS, satellite habitat data, etc. However, this is not considered a high priority.
- Spatial autocorrelation. The scale is basin wide with typically about 12 stations per basin and relatively spread out, so autocorrelation is likely not an issue.
- Data transformations – zero inflation?
    - Zero inflation parameter often has different response to the environment than the other two parameters.
    - Try negative binomial too.
- There are many issues with the GLM (Generalized Linear Model) approach which is

not necessarily linear. It is the maximum likelihood of fitting a model to data. It does a good job when the underlying relationship is known (e.g., log-linear), but when it is not known problems arise.

- The most suitable method seems to be to use Generalized Additive Models (GAMs; see examples in Kimmerer et al., 2009).
    - These models are highly flexible in that they can incorporate any number of covariates and categorical variables, and most importantly they can fit response variables to covariates with a relationship of arbitrary shape.
    - Many relationships of abundance or catch to environmental variables such as salinity are unimodal, such that linear or other specified functions are unlikely to fit across the entire range.
    - Since there is no underlying theory for the distribution of a species in salinity space, GAMS are the best suited to represent that distribution. Alternatives such as linear models with polynomial transformations or regression trees force structure onto the data that in most instances is unwarranted.
    - Sometimes GAMs will reveal a fit that is close to linear, in which case a GLM with a linear link function could be fit for clarity of interpretation.
- Another alternative presented was random forest algorithms, which might be useful but the PM-TAC has no experience with them. The modeling team is encouraged to investigate their utility for discussion at the next meeting.
- Remember, just because habitat is considered good or bad does not mean species will come to it or avoid it.
- The method for converting output of GAMs (or other algorithms), which can be any non-negative number, into HSIs scaled from 0 to 1 should be explored and the method justified (we did not discuss how this is done now). It might be better to run the GAMs with presence-absence data (and binomial error distributions), sacrificing analytical power for interpretability.
- Some of the HSIs are based on landscape attributes and other habitat characteristics developed from literature. The modeling team is encouraged to obtain the data used in these reports to try to develop more data-driven HSIs (rather than rule-based).
- For some species both monitoring data and literature relationships are available, and it may be worth exploring some combination of these. For example, it might be possible to use GIS data to determine the spatial pattern of the various habitats, and then overlay this result with that of the GAMs to produce an HSI that incorporates both kinds of information.
    - This should be explored in a pilot study because there are some limitations that may impede this process; for example, trawls and seine sets are in a rather narrow subset of the available habitats which may limit the extensibility of the results to other habitats.

FOCUS QUESTION

Can you suggest approaches for assessing the expected benefits vs. level of effort for potential model

improvements (e.g., including an array of subaqueous habitats, expanded data beyond LDWF for statistical model fitting)?

Are the four individual statistical modeling options discussed potentially useful in the master plan context? Does the recommendation to test each of the modeling options against the improved General Linear Model, seem reasonable? What is the most appropriate way of assessing improvements in model performance in the master plan context?

What are potential pros and cons of the ensemble approach; is it worth the effort?

- CARTS are useful for categorizing and grouping into hierarchies. They are good for thresholds, but processes and species distributions rarely have sharp thresholds or fall neatly into categories. Therefore, GAM is the recommended option.
- The GAMs should probably be run with a negative binomial error distribution (the Poisson error distribution used for CPUE data by Kimmerer et al., 2009 was not the most suitable). Regardless, the modeling team should examine diagnostic plots and apply other model-assessment tools before accepting results. The GAMs can readily output both mean predictions and uncertainties for any part of the data range. This can be used to propagate uncertainty into the model projections.
- Ensemble approach (multiple methods) may not provide value. Why not just use best fit to the data?

ICM-WETLANDS, SOILS, AND VEGETATION TEAM DRAFT RECOMMENDATIONS

GENERAL COMMENTS

- Overall, CPRA has developed a great approach to address wetlands, soils, and vegetation. The models are constructed at an appropriate level of complexity, and capture the key interactions between hydrodynamics, vegetation, and soil development.
- In the model, swamp forest exposed to saline water disappears and converts to open water; however, in reality marsh plants take over (vs. converting to open water). Consider a similar approach for the disappearance of fresh marsh (i.e., relax rules so that it is more likely to convert to more salt-tolerant vegetation).
- New studies/forthcoming literature suggests that organic matter might actually increase with SLR rates.
- Shallow subsidence should definitely be incorporated, but consider modeling it within the soils part of the model rather than as a boundary condition (i.e., fixed value by location). Be cognizant of potential for double counting of the effects of shallow subsidence.

FOCUS QUESTION

Can you identify any major issues with switching from a 'collapse threshold' approach to a more gradual reduction in elevation of bareground? Is there key research in this area that we have not considered?

Are the analyses proposed to explore environmental influences on organic matter accumulation reasonable? Are there other variables we could generate from the ICM that might be useful to explore, other than the hydrologic variables of water depth, inundation duration, water level variability, and salinity?

- Agree strongly with recommendation for forested wetlands (no collapse, let LAVegMod transition to wetland vegetation). This makes sense.
    - Consider a similar approach for conversion of fresh marsh to open water. It is acceptable to let storms kill off vegetation (e.g., add in 14-day salinity), but let it re-establish. It is good to add in methods to slow down the process of land loss as it is not realistic for a 500 m x 500 m whole cell to convert immediately to open water all at once.
    - Also examine to what extent vegetation dispersal from nearby plants limits establishment/recovery. Revisit this and consider relaxing the rules. Marshes should respond quickly to changing environmental conditions – species will come in. Consider reducing the dispersal restrictions of some plant types.
- First step is to figure out if organic accumulation increases, decreases, or has no change in response to flooding duration.
    - A suggestion is to look at inundation differently in the CRMS analysis (instead of/in addition to % time flooded):
        - Local rate of RSLR, elevation relative to tidal datum, flood tolerant vs. intolerant plant species
    - For analysis, group species to see general trends vs. breaking out species individually.
- It would be a useful exercise to redo the look-up table with the 10 years of CRMS data now have to see what the differences are.
- Consider putting shallow subsidence into the Veg model, and be careful to avoid double counting. Shallow subsidence is incorporated as an external variable, but also implicit in bulk densities. Look at bulk density data at various depths below the soil surface (both in the CRMS dataset and in the Morris self-packing relationship) to determine to what extent shallow subsidence is related to bulk density.
- Caveats with MEM or marsh organ approaches:
    - Biomass to organic accretion conversion requires belowground turnover rates with high uncertainty – better to use observed organic accretion rates from CRMS to parameterize relationships, use marsh organ experiments to

validate patterns/approach.
    - MEM approach generally shows increased biomass with increased inundation.

ICM-NUISANCE FLOODING TEAM PROGRESS

GENERAL COMMENTS

- It is good to see that CPRA is launching a new modeling component that will allow for high-frequency flooding to be directly considered within the 2023 master plan. The proposed activities are a significant improvement over the static sea-level-rise inundation sensitivity analyses carried out for the 2017 plan.
- Consider renaming the team as High Tide Flooding.
- While only considering tide and wind, events it is important to note that precipitation is not included (not within CPRA's purview, but the issue must be coordinated with other organizations addressing runoff in LA coastal areas).
- Erosion might be exacerbated by high tide flooding.
- Even if most communities are protected from high tide flooding by forced drainage systems, with increasing SLR how much time do these communities have?
    - Consider forced drainage levees and how rising water levels influence local decision-making.
- Adjustments to ICM still show under-prediction so there are issues with sensitivity to the processes that would create flooding.
- One option would be to count how many times an area becomes wet. Could use ICM to see if it was inundated.
- A suggestion is to look at events statistically and run the ICM to see if it was inundated. Could run individual events in ADCIRC; could base it on historical events.
- Does the resolution on the wind field affect the results? Possibly the 12 km winds from NAM are a limitation.
- It is difficult to create a synthetic event but it is possible to generalize it by wind data.
- It could be too arduous to have a high-resolution model for this purpose.
- Is it possible to capture event effects with probability so you know if it will increase or decrease over time?
- Because these events are higher frequency, lower impact, if the model could be more receptive to small changes, the model would tell us more. It is a communications piece and when you talk with communities, you want to be less wrong.

FOCUS QUESTION

Present day nuisance flooding (e.g., at LUMCON) is from events, not mean (nor mean high) water levels. Future nuisance flooding will be a function of both. How important will it be to incorporate event-based flooding ($n \cong 7$ from 2006-2013) when flooding at mean (or mean high) water level will be an order of magnitude greater in future decades?

More generally, do you agree with the team's approach so far? Do you have suggestions for focusing the discussion and/or analysis moving forward? What are the highest priority questions or tests? What are suggested methods for identifying, modeling, and communicating appropriate methods/ thresholds? What should we consider as we begin to think about options for risk assessment?

- Yes, high-frequency event-based flooding is important. As the episodic nuisance flooding line will shift farther inland with SLR, it will impact more and more communities.
- Consider using the historical record of high tide flooding to develop high-tide flood probabilities, where ADCIRC simulations are used to extend flooding information throughout the study area and to evaluate under SLR. Hindcast wind fields might be shifted spatially in order to account for natural variation not resolved in the hind casts or present in the historical record. It is suggested that probabilities be based on the longest observational records available, where storms for simulation are selected from the more recent period where observed wind field forcing is available.
- Because of the nuanced influence of high-tide flooding, accuracy in predicting inundation is more important than for extreme flooding events. Model improvements, such as increasing ADCIRC resolution, in populated areas currently and/or likely to be impacted by high-tide flooding should be given priority.
- Suggest a sensitivity analysis to see if the effort to improve the ICM to capture nuisance/high tide flooding is worth it, since it is not clear whether land loss/gain is sensitive to high-tide flooding.
- Some options for risk assessment and measurement of indirect impacts need to be included. Suggested looking at (a) school delays and closures, which correlates to work days lost for parents and (b) reduced sales/transactions as a metric for disruption, and other indirect impacts of high-frequency flooding.
    - Accumulative chronic impacts are important, they might be more important than acute event impacts.
- Highest priority questions/tests:
    - Whether land loss/gain is sensitive to high tide flooding
    - Sensitivity analysis could be useful to determine whether improvements to ICM are needed to capture high tide flooding.
- Liked the concept of the high-tide flooding categorization table as a communication tool.

OTHER COMMENTS NOT SPECIFIC TO MEETING #1'S FOCUS TOPICS AND QUESTIONS

- It is important to include in the planning process precipitation/inland flooding on flood extremes, and to include compound surge/rain flooding. While it is recognized that the state-of-the-art is not advanced enough to consider implementation for the 2023 plan, it is recommended this important process be considered and included in

future plans.

- It is important to more comprehensively incorporate community and human development aspects into the risk modeling, beyond what was considered in the 2017 master plan.

PM-TAC REPORT #2

DATE: 2020-01-16

RE: PREDICTIVE MODELS TECHNICAL ADVISORY COMMITTEE (PM-TAC) – JANUARY 2020 MEETING REPORT

PM-TAC MEMBERS

- Jen Irish - Virginia Tech, Civil & Environmental Engineering, Center for Coastal Studies
- Sam Brody - Texas A&M, Department of Marine Sciences
- Courtney Harris - Virginia Institute of Marine Science, Department of Physical Sciences
- Wim Kimmerer - San Francisco State, Estuary and Ocean Science Center
- Matt Kirwan - Virginia Institute of Marine Science, Department of Physical Sciences
- Mark Stacey - UC Berkeley, Department of Civil and Environmental Engineering

OVERALL COMMENTS FROM PM-TAC

- The modeling team continues to be thoughtful and thorough as they make progress on this comprehensive and ambitious effort.
- The format and content of the January meeting overall was very good, and it was considered an improvement over the previous meeting's format. The shift to an earlier start and end time to accommodate air travel schedules was much appreciated. However, there was a desire expressed to build in some time for the PM-TAC to meet in a closed session. It was suggested that some time (perhaps half an hour) be set aside at the start of the meeting for a PM-TAC closed session. It was also suggested that the optional pre-meeting dinner be used as an informal closed meeting of the PM-TAC.
- Overall, the PM-TAC felt that the volume of read-ahead materials was a bit much and found it difficult to focus on the most relevant sections. Perhaps, in the future, more

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guidance could be provided in terms of specific sections or page numbers that are most relevant to the focus questions. Further guidance about what will be presented at the PM-TAC meeting (which is understood may not be known until close to the meeting date) can be sent at any time, including as late as a day or two before the meeting.

PLENARY SESSION

RISK ASSESSMENT

GENERAL COMMENTS

- Consider how a major effort to develop the year zero initial condition helps make better decisions about how population growth and development plays out in the future.
- Consider applying the assumptions made for future growth to the current conditions to create a synthetic current condition that matches the important structure features but does not match address to address, house to house. This approach has the advantage of ensuring the current condition is consistent with future projections in addition to addressing privacy concerns.
- In regard to the sensitivity analysis of model aggregation, the return period of a given flood elevation will be different in the future. The same event having a 50-year return period today may only have a 10-year return period in the future. Once you get past the 50-year return interval, will the bias change? That 20-year return interval event may be mean conditions at some point in the future. Consider whether the bias persists in future conditions.
- Importance of privacy issues with data was reiterated/stressed.

FOCUS QUESTION

Given assumptions behind prediction of future conditions and potential implications in terms of reporting out results (e.g., questions about impacts at specific structures, expectations of precision), what are the advantages and disadvantages of various options for utilizing parcel level data (e.g., analyzing risk at the parcel level vs. aggregating parcel-level data for analysis)? What is the appropriate spatial scale for analysis and for reporting out results?

Is the recommended approach for estimating first floor elevations appropriate to fill in missing parcel level data for the master plan analysis of flood risk?

- Using the structure level works as the appropriate spatial scale for the analysis. While it is exciting to have structure level data it is too fine a scale for reporting results. It is most useful to report at the level that different management entities make decisions (e.g., Parish level or town level).

- Research tools are already at the parcel level, so there is no reason not to try to go there.
- Avoid aggregation bias issues particularly in urban areas. Do not aggregate across the urban/suburban development matrix.
- The Google Street View (GSV) analysis is impressive. GSV is outdated in some areas (like in Houston), so it is recommended to think through the implications of outdated data.
- Important to use the most detailed/accurate data vs. making wild assumptions. First floor elevation is at center of a lot of data exercises. Technology is rapidly developing:
    - Maybe go further, drones or other predictive mechanisms.
    - Start with year built and get more accurate with GSV/drones (e.g., photo recognition software).
- Cautioned to remember that the accuracy of inputs in flood heights has an uncertainty on the order of a meter, so outputs at inches is not really accurate or consistent.
- Suggest exploring developing representative units/parcels to save computation and try a lot of different scenarios. Consider Agent Based Modeling (ABM): Build the population to represent the real population where each entity is an agent that moves according to a set of rules in an environment; this can be efficient if you can describe those rules.
- Model at the scale you are interested in. If you change the scale, errors propagate. Could have a more robust result by doing the analysis at the parcel level, but consider aggregation for presentation and potentially pass-through to other components:
    - If parcel level analysis determined not to be feasible in master plan timeline, suggestion is to conduct a sensitivity test to evaluate how sensitive the outcomes are at varying spatial scales. Can also be used to quantify uncertainty at various aggregation levels.
    - Aggregation could consider community function, perhaps some weighting where the whole is greater than the sum (e.g., if 50% is damaged, is there a way to indicate that community has a very low function, is more vulnerable to market value change, for outmigration, etc.?). This might be an advantage of aggregating post-parcel level analysis.

HIGH TIDE FLOODING PATH FORWARD

GENERAL COMMENTS

- Engage communities early to help define the high tide flooding effort. If engaged early, communities will answer some of the questions re: storylines and consequences as they think about them differently.
- Work out of UC-Irvine that examines the co-development of flood threat research may be relevant (Luke, A., Sanders, B. F., Goodrich, K. A., Feldman, D. L., Boudreau, D.,

Eguiarte, A., … & Basolo, V. (2018). Going beyond the flood insurance rate map: insights from flood hazard map co-production. *Natural Hazards and Earth System Sciences*, v. 18(4).)

- Could include as part of the analysis what level of investment would be needed to keep the current level of protection.

FOCUS QUESTION

Given the analyses and possible approaches described in the team's report, is the recommendation to move forward with a community-based analyses justified? How can the approach be improved?

The team's report identifies two approaches to describe how communities will experience high tide flooding in the future as compared to present-day: increased frequency of water levels exceeding the impact threshold and a reduced difference between the impact threshold and mean water level (MWL) due to sea level rise (SLR) (resulting in reduced freeboard). Are there improvements that can be made to these two approaches? Is one preferred over the other?

- The biggest justification for moving forward with the community-based analysis is that it gives you results without the computational burden of running the analysis on the entire coast.
    - Choosing eight communities seems more than are needed to develop an outreach vehicle but not enough to be representative of the entire coast.
    - Surprised that none of the eight communities were urban, they seemed to be towns.
- Providing vignettes to show communities the challenges they will face with SLR in the future is a powerful outreach vehicle.
- If possible, it would be important to know a community's economic loss caused by high-tide flooding.
- People will respond to increased frequency of water levels, but what does that mean in terms of people's day-to-day lives? (e.g., percent of kids that cannot make it to school that day, percent of structures that can be inundated)
    - Consider ways to put an equity lens on that.
    - Analysis of roads flooded will be important (e.g., number of days a particular road would be closed).
    - Consider a systematic approach for identifying priority considerations across the selected communities.
- Improve approach by talking to communities now about how they think about flooding; this may provide insight as to how to describe the effects of high tide flooding on communities. See Luke et al. (referenced above).
- Give some thought to how results might translate (or not) to communities not selected for analysis.

ICM LAND CHANGE PROCESSES

GENERAL COMMENTS

- Elevation collapse is described in context of decomposition, subsidence, compaction, etc. – which rate you use reflects which process. What about surface erosion? The previous 'marsh collapse' elevation changes may have reflected a wider array of processes.
- The semantics get challenging - one word is used to describe multiple things. Try to better categorize. Perhaps an infographic could help.
- Could have chaotic model behavior when grid cells have different environments with sharp cut offs. Maybe thresholds could be designed to create more gradual change?

FOCUS QUESTION

A number of changes are recommended in the collapse threshold approach and vegetative transitions in the ICM. What types of issues might be examined during the model testing? What is the relative value of running tests based on the shorter calibration period, for which data is available, vs. for longer under future conditions when thresholds are more likely to be met, but when no data is available? Can the PM-TAC suggest approaches that could be used to assess the 'improvements' made?

- Approach is reasonable, but think about survivorship biases and if 95% confidence interval might be too restrictive a criteria (i.e., move further down into the data like 50%).
- Slow vs. fast collapse rates depends on whether we think of loss of elevation as only due to subsidence/compaction or erosion.
    - Evaluate sensitivity of outcomes to assumptions about mechanisms (processes) and calibration parameters leading to elevation change (e.g., compaction, erosion, accretion, etc.) – vegetated land vs. bare ground vs. open water.
- Do a sensitivity analysis as a way to flesh out the certainty/uncertainty of parameter space not yet experienced – approach would need thought.
- Sensitivity and longer period tests are good ideas. The longer-period tests might help identify potential for errors associated with extrapolation of calibration parameters/other instabilities (unrealistic results). Also, to assess how sensitive outcomes are to small changes in specified calibration parameters and thresholds (sensitivity tests).
- Consider a longer duration hindcast test (1932-present, e.g., associated with USGS maps). Would require a series of simulations with varying assumed initial conditions, given uncertainty in 1932, e.g., initial condition. This would give confidence in the expert judgement but there are problems in doing this.
- Think about using longer-term datasets in other places/regions that could be used for validation to assess the 'improvements' made.

QUICK UPDATES – STORM SURGE AND WAVES MODELING, ICM-HYDRO UPDATES, NEW BOUNDARY CONDITION DATA

GENERAL COMMENTS

- None

FOCUS QUESTION

To what degree and level of detail should we document and communicate the differences in model outputs that result from technical updates (e.g., changes in approach to develop boundary conditions, parameter standardization for ADCIRC, etc.) vs. those associated with model improvements designed to better reflect the dynamics of the system, e.g., improvements in spatial resolution, adjustment in land change?

Based on the description of the QA/QC process used in 2017, what improvements should be incorporated into plans for the 2023 analysis (for the ICM, including barrier islands, as well as for storm surge and wave and risk assessment models)?

- Focus reporting on any significant changes.
    - Focus on reporting additional processes included (precipitation, runoff, discharge) and on reporting fundamental changes in governing equations, model components, data sources used, storm probabilities and related methods for selecting storms simulated/used in the master planning process.
    - No need to report in detail on incremental changes. The exception being if there is an incremental change that significantly alters model bias (important to look at bias with surge magnitude). Presumably other incremental changes help to reduce uncertainty, which itself can and should be quantified through the validation steps.
- Be sure to evaluate error and bias in surge height with surge magnitude (especially at overland locations where there are a large number of non-events (no inundation) when moving to Kriging approach) and how that would translate into error/bias in the risk analysis. It is also important to ensure that distribution of damage (shape of curves) is retained.
- Regarding storm selection, at a minimum conduct a sensitivity test with the risk model for a pilot location using a large (>600) storm set and reduced storm set (randomly selected) to identify how sensitive the outcomes are to storm set size and set selected.
- Regarding QA/QC for ADCIRC: explore using response surfaces as a way to identify/filter out simulations with instabilities, if something deviates identify it as an outlier. Consider slightly increasing the total number of storms to compensate for discarding the occasional outlier.
- Regarding documentation and communication – it depends on the audience. If the

audience is technical, e.g., the PM-TAC, can say 'standard practice' and reference something instead of having a lengthy report.

BREAKOUT GROUP FOCUS QUESTIONS

ICM-BARRIER ISLANDS TEAM UPDATES

GENERAL COMMENTS

- Do not hold the line, we recognize that the barrier will retreat. Manage without over-engineering.

FOCUS QUESTION

What are reasonable parameters of barrier island thresholds to trigger placement of barrier island restoration, and how can use of these thresholds be combined with historic retreat rates to capture "managed" migration of islands? In addition, what are strategies for grouping profiles into restoration units?

What are potential weighting strategies for combining historic cross-shore retreat data with model predictions of retreat rates with SLR?

What are targeted strategies for starting to address uncertainties if/as there is time under the current effort?

- Suggest not modeling using thresholds because that may lead to chaotic behavior in the model (small changes in thresholds or inputs could lead to large changes in model outcome). Instead, consider approaches that would incrementally shift the barrier island toward the restoration target. The model could represent more frequent nourishment by "nudging" the barrier island profile towards the restored profile:
    - Should this be applied in z (PM-TAC thinks it has to be z) or x if the template aligns peak to peak?
    - Relatively 'weak' nudging allows islands to retreat. The nudging coefficient does not need to be linear
    - This approach ensures that ADCIRC runs do not respond to a sudden change and that runs for individual years reflect a gradual process
    - Ocean models often use a nudging factor to move the model state toward a desired model state.
- PM-TAC members consider the restoration units appropriate.
    - Consider the approach used in San Francisco Estuary Institute's Ecolab Operational Landscape Units (https://www.sfei.org/adaptationatlas). It has shoreline units, bathymetry offshore, topography onshore based on a robust

analysis. Consider looking at future predictions to see if units should be re-demarcated.
    - A large inlet makes sense for demarcation but anything smaller, e.g., a small breach, is not important.
    - Suggest that restoration units align with management units (i.e., counties, towns, or parishes)
- Weighting strategies:
    - Consider running LTA14 model to confirm historic values as a validation step.
    - The weighting of historical and predicted components (equation 2) should be reformulated so that the prediction is a correction to the historical. As currently formulated, it is a weighted averaged. Instead, the historical estimate should be the baseline estimate (it includes the spatial structure and variability) which is then modified by the model projections of future change using a coefficient to define the magnitude of the adjustment.
    - The coast is 'immature' and still adjusting. Retaining the historic retreat rates gives a more realistic response. Consider dropping alpha and adding perturbations by adjusting beta, i.e., beta would be zero if there was no perturbation. Set alpha equal to one.
- Addressing uncertainties?
    - The PM-TAC did not address this extensively, but the barrier island model will contain uncertainties in terms of future forcing conditions (sea level rise, wave energy, current velocities, storm track), and response (erosion rates, spatial variability in island response, inlet breaching). Suggest Monte Carlo approach to address uncertainty by varying parameters over a range of plausible values to evaluate the response.

ICM-WETLANDS ORGANIC MATTER ACCUMULATION

GENERAL COMMENTS

- None

FOCUS QUESTION

Given the challenge of developing strong relationships between hydrologic variables and organic matter accumulation rates (OMAR) based on the CRMS data, does the approach of using relationships based on belowground production from mesocosm experiments to inform and adjust OMAR rates seem reasonable? How might we assess the validity of the different approaches under consideration? Of the updated look-up table options (#1, #2, #3), is one preferable over the others? Are there additional model tests we should consider to understand the impacts of our proposed changes?

- While approach #3 seems reasonable, approach #2 is preferred:
    - The approach of modeling organic matter accumulation rates (OMAR) using

relationships based on belowground production from mesocosm experiments seems mostly reasonable. This approach (Approach #3) makes sense and is defensible based on other numerical models that link OMAR and belowground production. Suggest refining the approach by better determining the starting point for these projections (i.e., do not just assume that belowground production corresponds to 50% flooding frequency).

- However, approach #2 (lookup table based on static OMAR and self-packing densities) is preferable. In-situ data from the CRMS network indicates OMAR is not related to flooding while at the same time mesocosm experiments indicate belowground production declines with flooding. This disparity between OMAR and belowground production response to flooding can be explained by either a) reduced decomposition with increased flooding, due to reduced oxygen inputs from live roots (i.e., priming effect) or b) enhanced deposition of allocthonous carbon with increased flooding. Thus, the preference is for the simplest option; maintain OMAR's that are static with flooding.
    - The mixing model approach is reasonable – there is no need to include flooding. Do not make the mixing model basin specific, it should work over the whole coast.
- If option #3 is moved forward consider refining the approach by better determining the starting point for projections
    - Re-assess how to "pin" the curves (i.e., do not just assume that belowground production corresponds to 50% flooding frequency as is done now). Consider calculating mean water level for each group from the same data and pin there.
    - Re-consider calculations at the end of the curve (e.g., survivorship at 100% flooding).
    - The assumption of 10% refractory material is ok (usually interpreted as representing lignin content), but it could be adjusted if needed for calibration.
- Additional model test ideas:
    - Sensitivity analysis- if marshes are on the flat part of the productivity-inundation curve, then the various approaches will not be much different.
    - Compare average OMAR's in basins with different land loss rates. A positive relationship may support the importance of allochthonous carbon input (and thus static OMAR's and approach #3).
    - OMAR trends through time based on dated soil cores from marshes that are known to be becoming more inundated through time. Does OMAR increase, decrease, or remain constant through time?

ICM-HABITAT SUITABILITY INDEX (HSI)

GENERAL COMMENTS

- Abundance data are inherently highly variable, partly because the abundance of organisms in a habitat depends on factors both within and outside of that habitat. While the abundance of a given species within a habitat may respond to local variables such as temperature and salinity, it will also respond to conditions during residence elsewhere, and to variations in the species' predators and prey that respond to conditions elsewhere.
    - Thus, an analysis to develop an HSI that uses temperature and salinity within a habitat to predict abundance or occupancy in that habitat is likely to have wide confidence bands around the predicted value.
    - Therefore the HSI does not predict abundance very well, but does predict habitat use under the condition that these unobserved factors can be represented by their (unknown) mean values over the period of observation.
- Generalized linear models (GLMs) model the response variables as linear or other functions (e.g., log-linear, logistic) of predictor variables, which in the case of the HSIs are quadratic functions of temperature and salinity and their interactions, and a negative-binomial error distribution. These functions are easy to calculate and to apply in a predictive model, because they produce parameters for the quadratic equations that can be entered into the predictive model.
    - However, the quadratic functions may not provide a good fit to the data because they constrain the shape of the response. This can be checked by plotting residuals against predicted values and fitting a nonparametric curve using locally-weighted regressions or GAMs to check for evidence of deviation of the residuals from the expected value of 0.
- If the GLMs fail to produce results that pass this test, the alternative is to use generalized additive models (GAMs), which determine a curve that has no underlying model but is established by the data, together with a single parameter that sets how wiggly the curve is (i.e., the degrees of freedom).
    - The GAM and GLM results can be compared with the Akaike Information Criterion (AIC, or AICc for small data sets).
    - The principal disadvantage of the GAMs is that they do not produce an equation, so output must be put in the simulation model using a lookup table of values as a function of salinity and temperature.

FOCUS QUESTION

For statistical analyses, how might we partition data for training and validation? For example, we could use the most recent 6 years of data (2014-2019) to validate, or rerun the whole model with a random selection of year from the entire dataset (1986-2019). Another option is to use a k-fold cross-validation method (breaking the data into n partitions and testing each against the model).

The HSI team is currently updating the GLM models from the 2017 Master Plan to illustrate the improvements achieved by switching to GAM models. We intend to utilize more than one measure for comparing model fit and accuracy between GAM and GLM (e.g., R2, root mean square error (RMSE), and plotting predicted vs observed catch per unit effort (CPUE)). Are there other metrics we should consider?

Preliminary attempts at estimating uncertainty of HSI results have resulted in very wide confidence intervals. Are there steadfast rules on how large is too large when it comes to uncertainty/confidence intervals for HSI models? If uncertainty is still large, but smaller than GLM, is the model any better than the original? Any reason it should not be used at all?

- Partitioning data: The data set is relatively long, giving various opportunities for partitioning to provide separate data for calibration and validation. For convenience it was suggested using the data up to 2013 for calibration and data after 2013 for validation, or otherwise splitting the data into two contiguous parts for this purpose.
    - However, this is only practicable if the data are stationary (i.e., no trend in mean or variance) which seems unlikely.
    - Another suggested alternative is to split the data into two parts by randomly selecting years for each part. Given the small range of years and the likely presence of long-term trends in the data, random selection may produce biased results by clustering sequential years. Other alternatives would be to use every other year (with a random start) or two out of every four, or a similar pattern.
    - Another alternative is to use cross-validation. The attributes of that were discussed but some investigation is needed to determine the best method for this. Note that GAM does internal cross-validation but that is for setting the smoothing parameters, whereas the validation should be based on a different selection of years than the calibration.
    - Regardless of the approach used, there are not hard-and-fast rules about the amount of variability that is acceptable, beyond an interest in getting the best tradeoff between model complexity and uncertainty in predictions.
- Ways to deal with the high variability in the catch data used in the statistical models were discussed. These sorts of data typically have severely skewed distributions because of aggregation (schooling) and a high proportion of zero catch values from times and places where the species is absent.
    - This kind of distribution can be analyzed using zero-inflated negative binomial models or hurdle models (e.g., Zeileis et al., 2008). These models account for the zeros in two somewhat different ways. The hurdle model seems suitable; it first models the proportion zeros as a function of the predictor variables (including a smoother in a GAM), and then models the non-zero values using a negative binomial but dropping the predicted zeros.
- Model predictions should be compared with a null model (no predictors), and box

plots of null and model residuals used to assess the fit. Aggregating data for species with similar habitat use was considered but dropped because it would confound the count-based analysis described above.

- General consensus: Apply cross-validation, but first do some literature research and try the method on one set of data before proceeding with all. Conduct the above analyses of the GLM and GAM approaches, and in the meantime make sure that both methods can be used to provide input to other models (i.e., equation from GLM or lookup table from GAM).
- A subsequent thought: Another alternative type of model that might be useful is to apply boosted regression trees (Elith et al., 2008). These might be useful in the context of HSIs where there may be conditions that result in zero catch. However, none of the PM-TAC members is familiar enough with these models to give specific recommendations.

RISK ASSESSMENT/HIGH TIDE FLOODING

GENERAL COMMENTS

- A long-term goal could be to ensure critical facilities include major employers, churches, plus hospitals and consider service areas, but that may be too ambitious for the 2023 Coastal Master Plan.
- Not all model components need to be run at the same exact time scale (smaller set of storms at higher resolution, etc.).
- Consider the potential for nonlinearity with big infrastructure projects.

FOCUS QUESTION

What additional flood risk metrics, including metrics for high tide flooding, should we consider among or in addition to those presented in the reports? Which of these is best suited to inform project prioritization and decision making, and which are more suitable for communication and narrative development?

If the team develops a metric for the present value of risk reduction by interpolating hazard and vulnerability between time periods that are explicitly modeled, what is an appropriate balance between fidelity and level of effort? How many time periods should be modeled explicitly to inform accurate estimates when interpolating?

- Metrics - consider including:
    - Roads from DOTD and LiDAR to assist in the development of transportation metrics
    - Community services/facilities (and expanding the definition of critical infrastructure from the 2017 Coastal Master Plan analyses)
    - Data sets surrounding employment (and tracking data for the largest

employers)

- How could the data be used?
    - For an index
    - To show quantitative and qualitative impacts
    - For decision-making for the project selection process
    - For understanding access to facilities and critical locations.
- Consider weighting structures based on importance with types and tiers of "criticality"
- For the current plan, it is recommended to consider a consistent and single definition of "community scale" for analysis — population density was suggested as a way to distinguish communities. The definition of communities may be important for other aspects of master planning (e.g., nonstructural alternatives).
    - Consider percentage or number of structures inundated in community "x".
    - Use census tract demographic data and its distributions to make assumptions about demographics within that block as it relates to other data/information. This might be used as a constraint in decision making/project selection; some data could be collected at the block group scale.
- Report out on structures impacted with certain characteristics:
    - Demographics (by applying a distribution from tract level demographic data)
    - Number of mobile homes with depths greater than 1 ft above the first-floor elevation
    - Percentage low to moderate income (LMI), disabled, elderly
    - Selection biases? Would it make sense to put constraints on project selection in ways that ensure flood depths in vulnerable communities are not increasing?
- Consider calculating damage as a percentage of property value, consider using sales/transaction data.
- Takeaways
    - Reconsider how to account for critical/essential facilities (expanding the definition)
    - Consider flooding of roadways
    - Define communities
    - Equity metrics – consider increasing flood depths in vulnerable communities
- Interpolation: Temporal resolution does not need to be the same for all modeling components.
    - ADCIRC may only need to be run for a few discrete time periods to determine nonlinearity in flood elevation with sea level rise. Once you add a correction, this will get you within the uncertainty range. For example, select points at the baseline, year 50, and one in between.
    - May consider running more time periods for a smaller set of storms to assess other nonlinearities, e.g., with risk modeling.

- Consider project suite selection that is governed simultaneously by reduced expected annual damages (EAD) and ensuring populations benefiting (and not benefiting) reflect overall social demographics. Exactly how this will look needs some thought.

PM-TAC REPORT #3

DATE: 2020-10-12

RE: PREDICTIVE MODELS TECHNICAL ADVISORY COMMITTEE (PM-TAC) – SEPTEMBER 2020 MEETING REPORT

PM-TAC MEMBERS

- Jen Irish - Virginia Tech, Civil & Environmental Engineering, Center for Coastal Studies
- Sam Brody - Texas A&M, Department of Marine Sciences
- Courtney Harris - Virginia Institute of Marine Science, Department of Physical Sciences
- Wim Kimmerer - San Francisco State, Estuary and Ocean Science Center
- Matt Kirwan - Virginia Institute of Marine Science, Department of Physical Sciences
- Mark Stacey - UC Berkeley, Department of Civil and Environmental Engineering

OVERALL COMMENTS FROM PM-TAC

- It continues to remain clear that, overall, CPRA is taking a comprehensive, thoughtful approach in this master planning process.
- The modeling updates provided were impressive, and it is clear that the modeling team continues to be rigorous and nimble. For example, substantial progress has been made in developing and coupling components of the ICM such as the one-dimensional channel model. Substantial progress is also evident in the classification of structures for the risk assessment module (the streetview analysis).
- Given the goal of this initiative -- namely as a planning exercise -- CPRA should feel free to make decisions on methods, models, etc., that prioritize the master plan timeline by adopting best available or most appropriate, operational methods, models, etc. for the tasks at hand. While scientific advances and improvements continue to occur across all aspects of the processes considered in the master

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planning process, it is often not feasible within the master planning timeline to wait for these advances and improvements to mature. Specific examples include CPRA's appropriate decisions to move forward with best-available sea level rise (SLR) projections as of 2019 and to move forward with best-available joint-probability statistics as of summer 2020. However, it will be important to clearly document and explain these decisions in the 2023 report.

- Some members of the PM-TAC (not all!) found the focus questions hard to focus on in the context of the presentations. The presentations seemed to raise distinct sets of questions, and did not always connect directly to the focus questions provided. The following suggestions are offered:
    - It is important that focus questions are useful to both CPRA and PM-TAC in that the questions make more clear what input CPRA would like from the PM-TAC.
    - It is suggested that the focus questions be presented as individual bullets rather than in paragraph form, to make sure that each question is addressed.
- CPRA is commended for carrying out a highly effective virtual meeting in response to travel and face-to-face meeting restrictions during the ongoing COVID-19 crisis. The pre-recorded videos in particular were very good; this might be worth adopting for face-to-face meetings too, to free up more time for discussion. The following are some suggestions for improving future virtual meetings:
    - It is recommended that virtual meetings scheduled to run longer than two hours include a 15-20 minute break in the middle.
    - It would be helpful to have an additional, short (1/2 - 1 hour) virtual meeting in advance of the focus question meeting. The purpose of this meeting would be twofold: (1) to provide an opportunity to ask clarifying questions on the modeling update and (2) to provide an opportunity to confirm PM-TAC's understanding of the focus questions. This would separate the informational updates provided from the "watch-aheads" from the directed discussions of the focus questions.
- It is recommended that CPRA use something other than the sftp site for document dissemination to the PM-TAC, as all members encountered problems accessing the materials in the sftp site. It is strongly recommended that Google Drive be adopted for all future meetings. This approach would provide the most reliable, single-point access to the most current information. If this is not feasible, it is recommended that documents be sent by email to PM-TAC as they become available, where this is followed up by a single email summarizing and providing again all documents. The intent is to ensure that documents are not missed and are readily accessible

MAPPING UNCERTAINTY

An important goal of the 2023 Coastal Master Plan is to show uncertainty in future land change as land/water prediction surfaces based on FWOA analysis of model perturbations and environmental scenarios.

What to map:

Which scenarios (e.g., project selection scenarios, full set of SLR curves considered, etc.) should be used for development of these maps? Should the range of outputs from perturbations be mapped separately or in combination with outputs from the scenarios?

It is recommended that the team consider:

- There are too many dimensions to the problem to realistically display everything together. Do not try to create one map with everything combined; think carefully about the intended audience(s) and the 1-2 things they should take away, and target communicating those things well. It may be worth considering different map presentations for different audiences. It is suggested that simpler is better when engaging with the public and that we should be flexible in what we present depending on the audience.
- If model outputs are most sensitive to sea level rise and subsidence, focus on those.
- It is recommended that the SLR trajectories be preserved (reflecting different decisions we could make as a society) rather than combining or averaging them. This is expected to help with communication as various stakeholders will be familiar with SLR trajectories discussed in popular media and appearing widely in publications. In addition, combining climate projections would result in a chimeric trajectory predicted by no climate model.
    - Presenting “likelihoods” may be useful for internal analyses and for presentation to some stakeholder groups, but is not the best choice when communicating with the public.

Using the maps:

How should these maps be used for understanding project selection, and communicating uncertainty in model results? What are suggestions or important considerations in showing the collective variation in model results based on SLR uncertainty (within a Representative Concentration Pathway [RCP]), model uncertainty (based on the perturbation approach), and variation among RCPs?

It is recommended that the team consider:

- Take care with providing spatial information – people will focus on specific locations of interest without necessarily appreciating uncertainties in the outputs;
- Consider presenting sub-regional conditions as time trajectories potentially including cones of uncertainty in addition to the spatial information available from maps;
- When the goal is to evaluate project effects, communications should focus on factors that influence project success;
- Uncertainty maps will be useful for scientific audiences, but it is recommended to present information appropriate for the intended audience. It may be difficult to convey/communicate uncertainty to audiences who do not have much scientific background;
- Consider ways to turn uncertainty into "certainty", e.g., "we are pretty sure that we will see this outcome [land loss, annual damages, people/communities impacted, etc.] within the planning timeline".

STORM SELECTION IN THE ICM

What are suggestions or important considerations for how to select one or two specific sequences to use for project selection scenarios? Should storm frequency and intensity vary with the project selection scenarios, or should we examine that variable with additional uncertainty analysis and/or storyline scenarios outside of project selection? How should multiple storm sequences be used for the ICM uncertainty analysis?

It is recommended that the team consider:

- Storm selection could be project-centric (e.g., 2-3 storm scenarios for a given project to produce a range of outcomes);
- Consider storm sequencing as a sensitivity analysis, selecting a couple of sequences to bound the problem and expected outcome. The focus can then be on selecting a storm sequence to move forward with evaluating the projects. In this way it is not as critical for the sequence(s) to exactly match the underlying hazard distribution; rather the sequence is selected to prioritize evaluation of the projects.

SCENARIO SELECTION

For project selection:

Is our suggested approach to selecting scenarios for project selection, particularly related to SLR, appropriate given our project selection framework?

- The two scenarios presented by CPRA during the September meeting (aligning with

Groups F and H on slide 7 in "Scenario Selection Slides.pdf") are reasonable.
    - Using just two SLR scenarios for communicating projections would prevent various stakeholders (including the public) from focusing primarily on the middle scenario, for this reason two SLR scenarios seems advantageous compared to three SLR scenarios.
- The committee discussed at length whether or not there is a risk of overbuilding if a more optimistic SLR scenario is not considered in the planning process.
    - Omitting an optimistic, or likely best-case, scenario introduces both a risk of discounting the significance of projects that perform well under low (more optimistic) SLR and a risk of overbuilding should one of the selected higher SLR scenarios not be realized. If the risk of overbuilding is a concern to CPRA during its planning process, a third, more optimistic scenario would be valuable.
    - However, if the CPRA planning process assumes projects will come on line staged so they will be in place if and when they are needed, the risk of overbuilding when omitting this more optimistic SLR scenario may be small.
    - The committee defers the decision to CPRA as to whether or not a third, more optimistic SLR scenario is added--ultimately, it is CPRA's decision as to what factors they want to include in their project prioritization. If a third scenario is added, it is recommended that this be an optimistic, or likely best-case, scenario that aligns with Group C on slide 7 in "Scenario Selection Slides.pdf." The committee sees value in and would support either decision.

For 'storylines' describing possible future conditions:

What is an appropriate mix for the storyline analyses (given limited model runs, especially for ADCIRC)? What is a good balance between local detail and coastwide perspective? What are good examples of such 'storyline' assessment you are familiar with?

It is recommended that the team consider:

- Consider co-producing 'storylines' in collaboration with affected communities - let the people tell their stories!
- Consider presenting findings not as timelines but as degrees of impact, e.g., sea level will someday reach X, which may come as early as year Y1 (high scenario) or as late as Y2 (low scenario). Then cones of uncertainty could be incorporated into materials that are shared, since people have an intuitive sense of what they mean.
- Consider whether presenting information at a local level vs. coastwide is more effective for communication with the intended stakeholder groups. A local focus of presentations allows for a richer and more accessible presentation about uncertainties, but there is concern with providing hyper-local information. People

living in affected areas will gravitate to detailed local forecasts, interpreting them to mean, e.g., that their house will be underwater by 3 feet in 23 years.
    - Consider presenting information at a sub-regional spatial scale.
    - For a regional analysis, pick regions based on expected impacts (e.g., areas of larger-than-average expected impacts, or where projects are expected to have major influence).
    - Focus on where, and at what scale, and over what timeline, projects have an impact.
- Investigate opportunities for different analysis for particular communities (e.g., for high tide flooding, when a levee might overtop or when we might meet x threshold of flooding).
    - Convert impacts to some metric that resonates with a target audience.
- Colors matter and stories matter.
- Consider how to communicate that sea level will eventually reach "x", but that the time frame over which that happens is uncertain. In this context, CPRA could leverage the proposed temporal output in the new analyses adopted during this planning cycle in order to present results based on certain SLR values (in addition to in time). This additional perspective would allow inference of a SLR amount (and time period range) trigger for success or failure of project components.
- CPRA should tie these storylines into people's daily lives: If aggregating the analysis is not a level of effort concern, the "community" level information could be presented in a variety of ways depending on the intended audience. Going back to some points brought up at an earlier meeting related to high-frequency flooding, CPRA might be able to aggregate at community-relevant scales, e.g., a health district, school district, job base level, which might span multiple (or parts of) political-boundary divided communities such impacts as days of road closure, days of school closure, etc.

For overall communication:

What considerations should we take into account in selecting a single scenario that is used consistently when presenting maps and reporting outputs?

It is recommended that the team consider:

- Enlisting the expertise of scientific communicators to enhance and clarify messages to target audiences.
- Engaging affected communities early and often. Some members of communities will likely be uncomfortable with people from outside the community distilling their existence down to a number. Moreover, local communities can have knowledge built on decades or even generations of experience with the system. This knowledge can prove extremely useful in the master planning process, and seeking and using it can

greatly improve communication and buy-in by the local community.
- Controlling messaging: if CPRA creates one map to show land change/uncertainty, each person who sees it will extract something different, and CPRA loses the ability to control messaging.
- Ask participants in meetings and workgroups to self-identify to determine the level of detail to provide, and what information to solicit.

METRICS

How can we adjust our technical approach and/or communication surrounding metrics to ensure that the information is clear and usable for many purposes and that results are intuitive across multiple audiences? How do we incorporate metrics into the storylines to improve their accessibility or relatability? What is an appropriate spatial scale for reporting out?

How much should we incorporate our understanding of uncertainty into these outputs?

It is recommended that the team consider:

- Indices are useful for investigating change but are likely too abstract for communicating results.
- It is recommended to use relatable quantities to improve accessibility (e.g., number of times roads are closed, number of times people need to evacuate, number of days schools closed, number of homes flooded and how often, fishing yield, etc.).
- Land change output from previous master plans is an example of a really good metric because it integrates other variables but still means something on its own:
    - Consider something similar for flooding (e.g., # of times per year roads are flooded, or # of miles flooded, etc.) rather than an index.
    - While land change is something everyone can understand, it is recommended that CPRA identify ways to show/quantify that not all land has the same value; consider an approach to layer relatable metrics onto land to determine “value”.
    - Exploring results using metrics as constraints in the Planning Tool can also get at this.

BREAKOUT: PROJECT IMPLEMENTATION AND PHYSICAL IMPACTS

What considerations are important in terms of the timing of implementation and/or potential immediate impacts of adding projects on water movement, including for storm surge modeling and in relation to the storm sequence modeled in the ICM?

- In implementing projects within the model, the team needs to decide between alternative ways of representing them. Modes for representing them may be specific for the project type because for example, some projects may provide no benefit until the time of completion of construction, alternately for other projects their benefits are incremental over the time frame of project construction.
- Incrementally increasing benefits through the construction phase has the benefit of reducing the impact of a specific storm sequence (that occurs during the construction phase) on project value. Furthermore, construction of some projects may take many years and may cover large areas; in those cases project benefits can commence early in construction, even if the full benefits are not realized for many years.
- To account for incremental benefits, the modeling team could model the state of projects at the time of completion, and ramp up the benefits/prorate them during construction:
    - For example, all projects go in at the same time for model runs, but different rules could be used in the Planning Tool (PT) about how to prorate benefits; assumptions may differ for different types of projects – e.g., landbridges may take many years to complete but benefits increment over time. Other project types may also take years to complete, but benefits may not occur until after completion (e.g., diversions).
    - It was noted that the communication between the ICM and ADCIRC will occur at distinct timesteps. At minimum, consider implementing large projects like landbridges in the ICM in sections added at appropriate timesteps, so that project modifications are communicated to ADCIRC (for example, add landbridge benefits at Year 8 or 9 to show up in the landscape at Year 10 when they are communicated to ADCIRC).
- If different implementation methods are used in the model, it may be a challenge to communicate these differences to stakeholders, and it may also complicate the analysis of project outcomes.
- It is recommended that the modeling team select relatively simple methods for project implementation (either a step function upon project completion; or incremental benefits over the time period of construction).
- It is recommended that these simple methods be selected so that they can be applied consistently for projects of the same type. For example, perhaps include incremental benefits for all landbridges and all marsh construction projects; and use step functions at the completion of construction for other classes of projects (e.g., diversions).
- It is not clear that consistency between crest elevations for barrier islands considered in the ICM vs. ADCIRC is a concern.
    - It is suggested that the modeling team test and see if there is a problem first – is there an impact on waves and surge stemming from consistency in barrier crest elevations in the ICM vs. ADCIRC?

    - No need for another, separate process for lowering crest height due to overtopping.

How should we model projects that we expect to be built slowly over time (e.g., large levee systems, large-scale marsh creation and landbridge projects)? How can storm surge modeling at specific points in time be used in the damage model to reflect project implementation between those periods?

Note that some input to these questions is provided in the previous section. In addition, it is recommended that the team consider:

- If there is enough knowledge about how all the projects would be constructed to treat them consistently.
- There are two reasonable options: 1) linearly prorate benefits during construction, 2) step-change at the end of the construction period. Anything else is probably too complicated.
- Consider whether it is possible to treat large projects like Morganza to the Gulf as sub-projects.
- It is fine to account for benefits for different types of projects differently– landbridge vs. diversion, but recommend being consistent within each type of project (i.e., all diversions treated similarly).

BREAKOUT: METRICS FOR RISK ASSESSMENT/JPM-OS METHODOLOGY

What elements of new JPM-OS methodology should be incorporated?

- In regard to tradeoffs between longer historical record (e.g., HURDAT) that is potentially nonstationary or a shorter record with better stationarity: it is recommended that CPRA use a longer record to address potential problems with sample size, namely the low frequency of storms. The impact of nonstationarity might be evaluated through a sensitivity analysis using several different probability distributions derived from different duration datasets. Depending on time, uncertainty in the probability distribution could be considered directly by using multiple distributions with weighting, such as is being done by the Nuclear Regulatory Commission (see Gonzales et al., in particular Figure 1 logic tree on p. 54, and related discussion). One caveat to consider is that the pre-satellite historical record is likely weighted toward more extreme storms and may not accurately reflect likelihoods of less extreme storms. Reference: Gonzalez, V. M., Nadal-Caraballo, N. C., Melby, J. A., & Cialone, M. A. (2019). Quantification of Uncertainty in Probabilistic Storm Surge Models: Literature Review. ERDC Vicksburg United States.
- It is recommended to use the best available information and methods now and

acknowledge that the field continues to gain knowledge and improve methods. It is recommended, however, that CPRA continue to monitor these advances, with some level of comparison between CPRA analyses and new information, such as has been done already in comparing with the FEMA results from 2009. Also consider comparing across the relevant range of annual exceedance probabilities the following:

    - 2017 results (446 storms) vs. analysis with 645 storms
    - 645 storm results using Risk Team approach vs. ERDC approach
    - Different start years for HURDAT data (e.g., going back to 1938, 1950 or 1960) in order to identify any potential biases or inconsistencies.
- Given the way the statistics are handled, there are no concerns with having unrealistically large storms in the selected subset because they should have very low probabilities. These very large, unrealistic storms can be considered as a means for bounding the response at the very low-probability extremes.

To what extent should we incorporate EAD reduction over time into the decision analysis? Should we attempt to consider benefits from projects currently under construction, or continue with prior assumptions?

- It is recommended that CPRA consider presenting the information differently, maybe go beyond benefits-costs to build in more comprehensive economic, social or ecological components.
- In regard to CPRA adopting the USACE partial benefit assumptions:
    - While this is an interesting concept, it is noted that the focus of CPRA's activities is on planning. Since some potential projects are farther along in terms of thought/design such an approach could potentially bias some projects. It is recommended that CPRA not adopt this approach at this time. Rather, it is recommended that CPRA consider conducting some sensitivity analyses as a way to inform the 2029 master plan cycle, where partial benefits could potentially be included.
        - Consider potential benefits of projects that may take a long time to build and have benefits that extend out beyond Year 50, given the next planning cycle will consider a later end date.
        - Consider as a sensitivity test implementing all projects fully at the start of the simulation, or early in the simulation, as an upper bound on characterizing benefits. This might allow a more equitable comparison between projects. These benefits could then be prorated down during construction. However, it is acknowledged that to implement this correctly would require consideration of dynamic landscape changes on benefits.

What are suggestions or important considerations for development of non-EAD metrics to reflect aspects of damage reduction associated with risk reduction projects? Are there meaningful or relevant

thresholds for degree of damage or flood depths to inform analysis of asset exposure? How can equity and impacts on those with specific demographics be reflected? How should such outputs be communicated to clearly convey information to people who may not be interested in technical details? What is an appropriate spatial scale for reporting out?

- Work to better measure the value of different assets and weight them accordingly ("area catchment", or number of people served, etc.):
    - Consider ways to include things that are not as tangible like ecosystem services or recreational facilities, etc.
    - Multiplicative function – approach may favor smaller hospitals because people travel further to visit that hospital vs. a city hospital – levels the playing field a little.
- Consider the following meaningful thresholds for damage to vehicles?
    - How much does a road have to flood to damage cars? Six inches for cars; 12 inches for commercial vehicles.
- Consider what needs to be done to adjust the metrics the team is already using to address issues of equity:
    - Suggest not moving towards a SOVI approach.
    - Keep options open – provide Planning Tool with information for exploratory analysis (e.g., using metrics as constraints).
    - Summarize structure-level data at a higher spatial unit (communities).

BREAKOUT: ICM-HSI UNCERTAINTY

Does the workflow presented make sense in general, and what are important considerations to keep in mind while we continue to develop the approach?

More specifically, would it be helpful to examine quantitative metrics other than difference from the mean?

Should we narrow down the number of scenarios, and does it make sense to try to incorporate uncertainty in coupled land/water and temperature/salinity from SLR as well as model performance?

Should the analysis consider all species models or a subset?

- The HSIs are embedded within the ICM, but running the ICM is cumbersome in terms of time and resources. This results in relatively few HSI outputs and constrains the ability of the team to robustly explore how predictions using the HSIs may vary with both scenario selection and incorporation of uncertainty into the HSI predictions.
- Since the HSIs can be run in seconds to minutes a more fruitful mode of operation

may be to take output from the ICM and apply the HSIs to that. A small number of ICM runs could provide grist for a robust exploration of predictions from a large number of HSI runs.

- This is one area where the alternative approach recommended above would be valuable: i.e., to analyze or present output by impact (e.g., how high is sea level, what land exists, what is the salinity at some time in the future for all scenarios) rather than by pinning these impacts to a particular time. In other words, all scenarios reach the same sea levels and other conditions, but differ in when they get there. Instead of choosing scenarios, choose points along a trajectory.
- The limitation in this analysis will not be on computer time but time for people to analyze the data robustly. The high dimensionality of this problem will be reduced by focusing on impacts rather than trajectories, but many dimensions remain. A wide array of tools are available to reduce this dimensionality so that analysts can grasp the important responses and relationships. These include, e.g.,:
    - PCA
    - NMDS
    - Various plotting methods designed to display more than 3 dimensions
- ICM output influences the metrics used in the HSIs in two fundamentally different ways which should be addressed in different ways.
    - Changes in land vs. water area affect how much habitat even exists in an area, Thus, ICM output on land area for a given condition gives an upper limit to the habitat available, and further analysis would be confined to understanding the spatial distribution of that habitat under some future condition.
    - Changes in salinity, temperature, and other variables (vegetation, fragmentation?) influence how usable that habitat is. Therefore analysis of these variables would be the main focus of the HSI analysis in the suggested post-processing steps.
    - If landscape and salinity are tightly coupled in ICM output, the dimensionality of the HSI analysis can be reduced further.
- The analysis should be iterative,
    - A pilot analysis could examine a species whose HSI includes only a few predictors.
    - Explore that thoroughly before moving to species with more complex HSIs.
- The analysis should be robust in being able to forecast changes with the goal of being able to recommend actions or projects to forestall losses to populations:
    - Are there regions of parameter space where HSIs are unusually low?
    - Do the results vary regionally?
    - How does the suite of HSI predictions vary with different points in the predicted trajectory from the ICM?
- Use resampling methods such as bootstrapping to model uncertainty:
    - Resample from the error terms and generate output that covers all the

parameters.
    - This will take a lot of work to set up, but not much time to run.

BREAKOUT: ICM-LAVEGMOD UPDATES AND TEST RUNS

Do spatial and temporal patterns reflected in the results from recent test runs including these changes (G030-G031) seem intuitive?

- Yes. The spatial patterns are intuitive and make sense given the model changes.
- Clarify whether or not the timing and causes of vegetation changes and transitions to bareground and open water seem appropriate in the test runs.
- Abrupt change from Spartina patens to Distichlis spicata in one year might be a concern (too fast).

Which approach (G030 vs. G031) for calculating organic matter accumulation rates (OMAR) seems preferable?

- No clear preference, both make sense – the difference was only a 10% difference, but an extra mm/year of accretion could be an issue in some places. If a difference of 1 mm/yr is less than the accuracy of the model (and overwhelmed by error in starting conditions), suggest defaulting to the simpler approach.
- Partitioning (Chenier Plain vs. Deltaic Plain) is a good approach – a compromise between fully dynamic approach and having all marsh of same time accrete at same rate.
- Separating Chenier Plain based on data from only 3 saline marsh sites is fine – a more fundamental question is whether to break out OMAR between the Chenier Plain and delta plain, and that makes sense.
- Important to have a conceptual understanding of why some marsh types have higher OMAR than others, from a mechanistic standpoint (e.g., forested wetlands have the highest rates)?

Are there limitations we should be particularly cognizant of when interpreting results of project runs?

- OMAR is not fully a function of water depth/flooding, but the coarse behavior is captured by partitioning between different portions of the coast, and the approach is good.
- Other marsh models indicate that the starting elevation of the land (i.e., elevation capital) is a large source of uncertainty, on par with the actual model dynamics (i.e., accretion processes). Good news is that it means the detailed questions related to OMAR are less critical. Bad news is that it is an extra source of uncertainty that is particularly relevant over decadal to multi-decadal timescales.
- How to delineate active delta plain (including for diversions).

- Most straightforward approach is to define the active delta plain based on mineral deposition rates, changes in mineral deposition rates through time, or mineral deposition rates relative to average in the ecoregion. The assumption being that the active delta accretes faster than it did in the past, or faster than the surrounding area.
- Other approaches could define the active delta based on changes in habitat (i.e., active delta = places with newly formed wetlands, or places where vegetation is changing through time to more flood intolerant species) or shallow subsidence (active delta = places where shallow subsidence is high, assuming that shallow subsidence increases with mineral deposition as a function of compaction). But these alternative approaches have limitations. For example, changes in habitat would not capture active subaqueous deltas, both habitat and shallow subsidence may lag behind mineral deposition rates, and the shallow subsidence approach would only work if that process was dynamic in the model.

What specific effects or changes should we look for during QA/QC of project runs?

- The model is clearly working as intended; now the team needs to check that the changes led to an improved ability to predict changes compared to observed data (CRMS), including total accretion rates. This is the same approach as CPRA did before our first meeting, which motivated these model improvements in the first place. This final QA/QC can only be done after the veg model is integrated with other ICM updates, including dynamic sediment deposition.

PM-TAC REPORT #4

DATE: 2021-02-11

RE: PREDICTIVE MODELS TECHNICAL ADVISORY COMMITTEE (PM-TAC) – JANUARY 2021 MEETING REPORT

PM-TAC MEMBERS

- Jen Irish - Virginia Tech, Civil & Environmental Engineering, Center for Coastal Studies
- Sam Brody - Texas A&M, Department of Marine Sciences
- Courtney Harris - Virginia Institute of Marine Science, Department of Physical Sciences
- Wim Kimmerer - San Francisco State, Estuary and Ocean Science Center
- Matt Kirwan - Virginia Institute of Marine Science, Department of Physical Sciences
- Mark Stacey - UC Berkeley, Department of Civil and Environmental Engineering

OVERALL COMMENTS FROM PM-TAC

- It remains clear that, overall, the CPRA is taking a comprehensive, thoughtful approach in this master planning process.
- CPRA is again commended for carrying out a highly effective virtual meeting in response to travel and face-to-face meeting restrictions during the ongoing COVID-19 crisis.
- The PM-TAC noted that overall fatigue with virtual meetings, along with the time lapse between PM-TAC meetings, may lead to PM-TAC members raising comments and questions that were previously addressed during the current meeting or during previous meetings. CPRA is encouraged to be direct with PM-TAC in terms of redirecting committee discussions should this occur.
- The PM-TAC appreciated the opportunity to hold a closed session, and prefers to hold the closed session as soon as possible following the open sessions. PM-TAC

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recognizes that scheduling conflicts outside of CPRA's control necessitated a delay between these two sessions for the January 2021 meeting.

ICM

Several updates we considered during model improvement were not ultimately implemented for the 2023 ICM. These include, for example, a pilot study to test more dynamic barrier island modeling, adding response of organic matter to hydrology, and expanding the dataset for HSI development beyond LDWF data. Which of these, if any, stand out as high priorities for future model improvements and why?

It is recommended that the team consider:

- Answering this question broadly: rather than considering specific improvements to further develop the models, think about ways to challenge modeling with alternative methods and think about things to explore (e.g., a global sensitivity analysis, and an in-depth look at storm sequencing and river flows and how they may interact)
- Early in the next plan cycle, comparing any limitations revealed by global sensitivity analysis to results of the uncertainty analysis run for the 2023 Coastal Master Plan. This comparison could provide guidance on where to focus efforts for model improvement in the next master plan cycle. It is important to conduct sensitivity analysis early in the next cycle, before updating the model again (might not need to change the model as much next time):
    - Testing is key to identify model improvements – need to know whether model improvements matter.
    - Reflect on what aspects of system dynamics are not well represented, and, conduct sensitivity analyses to assess the value of improving these aspects of the models. This would be driven by model performance in estimating effects of projects under a variety of conditions, and should be done early in the next phase, before 3rd- and 4th-order model improvements based on experience of the modeling team are considered.
    - Sensitivity analysis may reveal points of weakness that indicate a need for improvements that so far have been set aside as unnecessary (or impracticable).
- As you begin work on the next master plan, taking time to test the existing framework against "benchmark" data sets to help identify which parts of the framework are most appropriate to focus on for improvements. More specifically, conduct some model hindcasts (maybe 10 year?) to see how well the model replicates natural behavior or the results of actual projects (using the actual storm sequence instead of synthetic, actual sea level history, etc.):
    - Ideally, the model hindcast would be run for specific projects that have been

recently implemented. How accurately did the model predict the rate of land building, the change in marsh accretion rates before and after project implementation, etc.?
    - But also consider analog studies (e.g., natural crevasses as analogs for diversions, hurricane sediment deposition or overwash fans as analogs for dredge disposal).
    - Using present-day model input (i.e., DEM, vegetation type, etc.) investigate whether the model successfully predicts spatial variability in response variables. For example, during the most recent meeting there was a graph showing modeled total accretion rates versus measured total accretion rates for many different locations. That helped convince the PM-TAC that the OMAR methodology was reasonable. Expand this concept and consider other response variables (e.g., rate of land loss, historical changes in vegetation/salinity zones, etc.).
    - Decades of land change data are available for the Wax Lake Outlet/Atchafalaya Delta. The team could use a sub-domain of the ICM to look at Wax Lake, Fort St. Philip, Mardi Gras Pass, etc.
    - In general, focus on rapidly evolving parts of the landscape because they are more analogous to projects (i.e., sudden change), and the input data can be more recent (i.e., the initial DEM may only need to be 10 years old whereas one from 100 years ago would not be available).
    - A challenge will be identifying what level of model hindcast performance is satisfactory. Is the model correctly identifying the direction of change, rate of change, or something else? It seems like being able to rank proposed projects is most fundamental. Defining the questions to answer through hindcast will be important.
    - If this item is a priority for CPRA and there is room within the agenda, the PM-TAC is willing to discuss/brainstorm on this topic during an upcoming meeting.
- The recommendation to expand on the analytical framework during the next master plan cycle reflects the PM-TAC's recognition of the maturity and thoroughness of CPRA's cyclical process of model improvements, testing, and forecasting for master plan upgrades. There may be a temptation to begin refining the models where the modelers see rough edges or other needs for improvement. However, for the next cycle it might be timely to explore the existing model suite more comprehensively. Some of the specific suggestions above would be part of this. However, to design this process would require a broad-based but careful look at what the modeling structure is meant to determine, and what inputs (included in the model or not) are likely to affect whether the model can make useful forecasts. Since the purpose of the suite of models is to help with project selection, using the models to assess past projects would provide a valuable assessment. Another approach to consider is to conduct simulations with alternative storm sequences such as the reverse sequence or

randomized sequences.

We developed a new approach for determining a storm sequence for the 2023 ICM. How much difference do you expect the new storm sequence to make in outputs of interest? Is storm sequence something worth pursuing in more detail for future master plans (e.g., exploring other ways to account for episodic events), or is there value in maintaining a consistent approach?

It is recommended that the team consider:

- Trying two scenarios: invert the storm sequence to see if it makes a difference.
- For storylines, using historical storms or sequences, as this might be useful, more accessible.
- Running the 2012 approach and the 2023 approach to compare results.

RISK MODELS (ADCIRC + SWAN AND CLARA)

The selection of 90 storms for project selection analysis was based on characteristics of the larger storm suite and ensuring that the subset does not over- or underestimate flood risk. To what extent should additional storms be modeled for storyline analysis, for example, to identify local patterns of flood risk (e.g., those potentially modified by restoration projects)? Or is it preferable to demonstrate these effects using storms from the subset?

It is recommended that the team consider:

- If the 90 storm subset has a storm with relatively severe impacts that do not seem improbable, using that to represent/capture the effects of severe storm(s) and relate results to the wider probability space. However, there is a need to be careful to balance messaging so as to not overdo reporting of those less probable events with extreme consequences.
- Focusing on impacts (damage, etc.). For example, CPRA might consider:
    - Finding an historic storm that produced a large impact, e.g., Katrina, then deteriorating the landscape for 50 years, add sea level rise and identify what type of storm it takes to generate the same impact. Additionally, CPRA might:
        - Look at how much development, population shift, and sea level rise would need to happen to produce the same damage with a ‘lesser’ storm.

How might we apply Matt Hauer’s additional work on migration corridors, if at all, to track where coastal residents might relocate to if displaced? Hauer’s work might provide a better understanding of the extent of relocation within areas of the Louisiana coast, either due to land loss or as a result of buyout policies, but this may be a secondary question if the number of people and assets expected to

relocate is relatively modest. If we don't use this approach, what simplifying assumptions should we make about displaced residents?

It is recommended that the team consider:

- Not using migration corridors in the current master plan, due to potential biases such an approach might introduce using commonly-employed methods. Limitations in the methods for migration corridor analysis include:
    - Displacement is hard to predict at a meaningful scale.
    - Bias in existing data towards evaluating people with higher socioeconomic status; simple is OK unless we know enough to ensure we are not being biased.
    - Easier to predict development and population growth than migration corridors.
    - It is very difficult to track migration of individuals after a disaster or community-wide disturbance.

This possibility, however, should be revisited for future master plans as advancements are made in migration corridor projections.

What should be considered when selecting types, or categories, of critical infrastructure for the exposure analysis? Previous master plans have focused on a relatively narrow subset of infrastructure dominated by oil and gas production, navigation, transportation, and other energy infrastructure. This list could be expanded or modified to consider additional "lifeline" infrastructure types (e.g., hospitals, water treatment) and/or allow for more focused narratives on service disruption.

It is recommended that the team consider:

- Being more inclusive in terms of critical infrastructure types – more information is better to allow for differing perspectives on what is critical infrastructure.
- How important the different types of critical infrastructure data are to stakeholders, to the design and implementation process, etc.
- How the Planning Tool could use this to show differences among alternatives.
- Revisiting this topic when the alternatives have been formulated and the effects of groups of projects can be considered. This might help to identify/focus on those infrastructures most impacted by the project(s).

GENERAL LESSONS LEARNED

Describe any major limitations of the modeling approaches that will be used for the 2023 Coastal

Master Plan and how those limitations could reasonably be addressed in the future within the existing master plan modeling framework. Provide suggestions for future model improvement efforts based on lessons learned (i.e., what should we have done differently, or what should we do differently next time?)

- See earlier discussion on ICM.
- Evaluate whether an ensemble approach would add significant value in evaluating the effectiveness and selection of projects across the future scenarios. For example:
    - Use many realizations of storm sequencing to evaluate damage, infrastructure/population change, etc.
    - Use Monte Carlo approaches to more rigorously capture uncertainty due to, for example sea level rise trajectory, specific model parameters, etc.
- Consider protocols for assessing impact, assessment, and self-reflection, namely regular assessments of whether the Master Plan is achieving its goals and objectives, and a process to adapt management strategies if the Master Plan is not achieving measurable targets. This is really important for longer-range initiatives. How well did the community do, how well is the plan performing--at a community level.
- The PM-TAC appreciated receiving an introduction to the Planning Tool that the CPRA modeling efforts support. We would like to emphasize the importance of understanding how the modeling results are used in planning decisions, and we believe the modeling team should ensure its sensitivity analysis evaluates the impact of modeling decisions on the ultimate planning decisions. It will be valuable to ask what aspects of the modeling framework are most strongly determinant of the outcomes of the Planning Tool so that model improvements can be focused on those components.
    - If the approach in the Planning Tool is altered, or if alternative approaches are being considered, analysis of the modeling output and its sensitivity should, of course, be viewed in the context of those approaches.

We look forward to hearing more about linkages between the Planning Tool and other model components, and proposals for associated sensitivity analyses, in future PM-TAC meetings.

PM-TAC REPORT #5

DATE: 2021-09-17

RE: PREDICTIVE MODELS TECHNICAL ADVISORY COMMITTEE (PM-TAC) – AUGUST 2021 MEETING REPORT

PM-TAC MEMBERS

- Jen Irish Irish - Virginia Tech, Department of Civil and Environmental Engineering
- Courtney Harris - Virginia Institute of Marine Science, Department of Physical Sciences
- Wim Kimmerer - San Francisco State, Estuary and Ocean Science Center
- Matt Kirwan - Virginia Institute of Marine Science, Department of Physical Sciences
- A. R. Siders - University of Delaware, Disaster Research Center
- Mark Stacey - UC Berkeley, Department of Civil and Environmental Engineering

OVERALL COMMENTS FROM PM-TAC

General:

- As noted in prior reports, it continues to remain clear that, overall, the CPRA is taking a comprehensive, thoughtful approach in this master planning process.
- CPRA is commended for quickly and effectively pivoting to a virtual format for the fifth PM-TAC meeting, in response to rising COVID cases.
- The PM-TAC appreciated the opportunity to hold its closed-door session within two days of the main meeting. The result was a more focused and efficient discussion centered on drafting responses to CPRA's focus questions.

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Communication of Outcomes and Results:

- The PM-TAC has previously suggested a complementary view of the model projections that might help with communication. We continue to recommend that some projections be presented in terms of the range of years over which a given level of impact is predicted to occur under each combination of scenarios and projects. Although many processes (e.g., erosion and restoration) take time to develop and may have a somewhat erratic trajectory; many impacts we have discussed (e.g., flooding in certain areas) are events that have a probability that increases over time. Viewing these seemingly inevitable events through the lens of probability distributions is useful and familiar to scientists and engineers, but less so to others. A more useful (because transparent) way of displaying risks of such events may be as a time frame over which some (presumably unacceptable) event is more likely to occur than not.
    - For example, at some point in the meeting we discussed the resilience of neighborhoods to nuisance flooding. Presumably that resilience will begin to break down when flooding occurs with greater frequency, duration, or depth. The timescale over which this is expected to occur would likely influence community members' decisions to stay or go. People living in those areas may be willing to stick it out if flooding is not expected to significantly worsen for several decades. However, they may leave if they expect flooding y to become intolerable within a decade. Thus, a statement that X amount of flooding in a particular area is likely to occur annually starting sometime between 2025 and 2035 and, thus, is likely to stimulate household or stakeholder group action (e.g., regarding real estate investments, infrastructure maintenance, relocation, etc.) around that time. But, if the year at which this is expected is 2180 households and stakeholders may not take action. (Note that some people are likely to take action only when they have to swim, but one cannot do anything about that).

ADDITIONAL SCENARIOS FOR EXPLORATORY ANALYSIS

For the two environmental scenarios selected for project selection, sea level rise (SLR) curves (and associated hydrology) were selected from a wide range of potential values and shallow subsidence was applied as the 25th and 50th percentile of the range for each ecoregion. Exploratory analysis is planned to examine how land area and flood risk change with different future scenarios. Of the many runs that could be done, how should CPRA consider which additional scenarios to explore (e.g., sample across the range of possibilities, focus on the extremes, show different combinations such as high subsidence, low SLR)?

- The PM-TAC supports the decision to include two environmental/sea level rise

scenarios (S6 and S9 were presented at this meeting), and PM-TAC supports considering sea level rise and subsidence jointly in those scenarios. Different combinations of these two factors (sea level rise and subsidence) are not a priority, in the view of the PM-TAC, since the impact of the factors are understood to be quite similar. As PM-TAC noted at previous meetings, using two scenarios ensures that the audience does not default to the "middle" one, and will encourage more critical thinking and careful interpretation of the results. Further, the PM-TAC appreciates that the scenarios, to great extent, bracket the likely range of outcomes.

- Following this meeting, the PM-TAC was informed that the modeling team was considering switching from scenario S9 to scenario S8 for sea level rise in order to better reflect the IPCC projections that were recently released. The PM-TAC is not immediately supportive of this change, and would want to hear more discussion of the justification for this decision. Switching the "high end" scenario to one that is closer to the IPCC projections means that the two scenarios no longer span the entire range of outcomes that are reasonably likely, although PM-TAC can also see the benefit of not including "alarmist" scenarios that are high impact but low likelihood. Using the S8 sea level rise scenario plus the 75th percentile subsidence range (instead of the 50th) would perhaps allow both congruity with the IPCC projections while still capturing a full range of possible outcomes. This decision is an important one, though, and merits more evaluation and discussion.
- If there is an opportunity to complete a wider range of exploratory scenarios, the PM-TAC recommends a focus on the Mississippi River discharge instead of additional sea level scenarios. The basic sea level/subsidence scenarios are already spanning likely future conditions, but the model for Mississippi River discharge has a number of assumptions built into it regarding whether to prioritize peak flows, low flows, or annual discharge. The impact of each of these aspects of Mississippi River discharge may vary across different model components; for example, peak flows may be important for land building, but low flows may be most important for establishing salinity in coastal habitats, and they are not well represented with the current approach. Exploring a wider range of variability in Mississippi River discharge, including extreme conditions and events, and the sensitivity of the model to that range of variability for each of the sea level scenarios, would be prioritized by the PM-TAC.
- Finally, the PM-TAC would like to comment on one other aspect of the modeling framework for which a concern emerged during this meeting. When viewing the projections for land gain/loss, the PM-TAC realized that the initial conditions for some plots of land were being categorized differently for different scenarios (i.e., for one scenario, a plot might start as water, and for another scenario it might start as land). Through discussion in the meeting, we learned that the reason for this difference was that the initial conditions were set after a 2-year "spin up" which is run under conditions for the respective scenarios.
    - We understand that the 2-year spin-up is needed to account for diversions

that are not yet present, but will be present before projects are implemented. However, the way the spin-up is currently being implemented is highly confusing and is inconsistent with how model spin-ups are typically done. The problem lies in the fact that the modeling team is using the first two years of scenario simulation to also let the system adjust to the new diversions. This means that differences in weather for the scenarios (rainfall, discharge, storms, etc.) is causing the scenarios to diverge from one another before their initial conditions are specified. Instead, the spin-up of the model to account for diversions that are coming on-line should be done prior to the imposition of the two scenarios (i.e., from year -2 to year 0), then the initial conditions for the two scenarios will be consistent with one another.

- The PM-TAC understands that this difference between the scenarios will not affect project selection and prioritization, since those are being evaluated within scenarios and all projects fall well beyond the spin-up period. But, the current approach will create challenges in communication, and misrepresents the stages of model initialization and spin-up. It seems to the PM-TAC that it would be a straightforward fix to run two years of the model with the diversions on and a single set of forcing for all scenarios, then establish the initial conditions for the two diverging scenarios after those two years are complete. PM-TAC recommends the modeling team make this change.

POPULATION PROJECTION DATA

Future population projections, including information on age, sex, race, and income, have been developed for census block groups across the coast. The scale of the projections means they do not map directly onto other geographic units used in the analysis. In addition to their use in driving change in future assets, how can they be used to explore the implications of both FWOA and project selection on different demographic groups for the 2023 and/or the 2029 Coastal Master Plan analysis?

- Population groups of interest could be mapped and used to both inform and evaluate project selection. The Planning Tool Metrics could include demographics as either decision drivers or checks that project selection is achieving the master plan objectives – e.g., protection of Indigenous groups could be a metric for cultural heritage preservation, or protection of people across a diverse range of incomes might be a component of a working coast. Population is already included as a metric for avoiding flood damage, and other demographic groups of interest could be added in a similar manner.
- Equity is not currently listed as a master plan objective. If equity were an objective for the plan, demographics could also be used to assess whether selected projects are primarily protecting certain groups (i.e., wealthy property owners) and not protecting

others. Once potential projects are selected, it would be possible to identify the areas protected and compare the demographics of people in that protected area with demographics of people in unprotected areas nearby or along the coast. For example, Houston, Texas, has used a social vulnerability index to prioritize flood mitigation projects that would protect socially vulnerable communities. Without going that far, CPRA could at least verify that its selected projects will not further exacerbate historical inequities and patterns of disinvestment in coastal Louisiana.

- The meeting's conversations also raised questions about how population projections are being translated into asset classes, elevations, and spatial distributions. Assumptions that development will continue to occur in the same relative classes, historical elevations, and geographic distributions as in the past is an understandable simplification. However, it does presume no government action will be taken to direct development into less risky areas or to require safer building practices in the future. It will be important for CPRA to note this assumption and its implications that state and local governments could do much to reduce future risk beyond the structural measures recommended by the master plan. This will be an important communication point.
- To help illustrate the potential value of government actions to direct development, modeling could, in future rounds of master planning, explore scenarios such as: What if all new assets were presumed to be built to an elevation of base flood elevation (BFE) + 2 feet? What if population growth were presumed to result in densification rather than sprawl (i.e., increase density of existing assets rather than add new assets [turn single-family homes into multi-family homes])? This would be a significant advance in modeling the potential effects of land use regulations and building codes.

APPLICATION OF NEW EXPECTED ANNUAL STRUCTURE DAMAGE (EASD) METRIC

When and how can EASD be combined with EAD$ into a single decision driver, and if combined, what factors should be considered to determine the appropriate weighting? What asset classes (i.e., occupancy types) should be considered for EASD? Should information be reported out on exposure by asset type or in aggregate, and how might we use different asset categories in different ways (e.g., as checks against the 'working coast' objective)?

- The PM-TAC appreciates the novelty of the EASD and commends CPRA's forward thinking in developing EASD as a means for promoting equitable decisions. The PM-TAC observed that CPRA's development of the EASD is in direct response to criticism received on the past model.
    - The PM-TAC acknowledges that EASD may be viewed as a middle-of-the-road approach, being neither traditional nor progressive. Namely EASD falls

somewhere in between an approach dependent solely on a Social Vulnerability Index and an approach dependent solely on EAD$. PM-TAC observed that because of its middle-of-the-road nature, EASD may not represent either extreme, traditional or progressive.

- Combining EASD and EAD$ would require implicit or explicit weighting, and at present there is no justification for such weighting. Rather, it is a subjective policy and ethical decision to decide on weighting. Thus, the PM-TAC:
    - Discourages CPRA from combining EASD and EAD$ into a single decision driver. Rather, it is important to present both separately.
    - Recommends CPRA identify and clearly communicate the advantages and disadvantages of both metrics (EASD and EAD$) while clearly articulating assumptions made and data used in developing both metrics.
- Both EASD and EAD$ can be useful to have, in that some stakeholder groups may prefer EASD and others EAD$. However, if CPRA presents both, there will be stakeholders on both sides focusing on the one that is most advantageous to their group. While this potentially creates conflicts between stakeholder groups, this may not be avoidable. The CPRA modeling effort could shine light on this conflict, and not hide it under an aggregated metric.
    - PM-TAC recommends CPRA consider an EASD-EAD$ sensitivity analysis for the project selection. Currently, robustness analysis is used to select projects with respect to various environmental outcomes. This concept could be extended to the EADS and EAD$ metrics in order to evaluate which projects are robust with respect to both cost and social aspects.
- In regard to asset classes and aggregation, the PM-TAC prefers keeping the various asset classes separate and at a minimum recommends that residential be kept separate from other classes.
- There is a minority view in the PM-TAC that CPRA should not report EAD$ and should report only EASD. Some PM-TAC members feel that reporting EAD$ is necessary both because it is the established approach and because decision-makers will require information about the cost-effectiveness of projects. Other members feel that reporting EAD$ will enable decision-makers to ignore the unfamiliar EASD and to continue to select projects on the basis of EAD$ alone and therefore result in further inequities in the distribution of projects.

NONSTRUCTURAL RISK REDUCTION

Given that nonstructural flood risk reduction will not be described by a list of specific nonstructural projects in the 2023 Coastal Master Plan and given limited time and resources, what range of issues should the risk team explore with variants (e.g., changing elevation targets and rules for acquisition) to characterize the costs and benefits of nonstructural risk mitigation in coastal Louisiana (i.e., how should the team set up an experimental design to inform/characterize the effects of a nonstructural

project on risk)?

What critical information can we develop with the models we have to inform the various risk reduction programs that will implement these projects (e.g., for them to prioritize approaches or regions)?

- Acquisitions are a particularly fraught strategy, both politically and ethically. CPRA should think very carefully about how they will communicate any results, and the PM-TAC recommends against any modeling that appears to prioritize acquisitions in certain regions.
- Instead, CPRA could characterize the effects of nonstructural projects by providing upper and lower bounds to the costs and benefits of acquisitions and elevations. For example, analyze the least possible amount of elevation and acquisition (i.e., no acquisition or elevation; FWOA), the greatest (i.e., every residential asset is acquired, or every asset is elevated), and a middle ground (i.e., all new assets are elevated to BFE+2, or all residential assets exposed to more than a certain risk threshold such that elevation is not technically feasible [e.g., 14' inundation] are acquired). In the last case, the decision that elevation is "not technically feasible" above a certain height will be challenged, so whatever threshold CPRA chooses, it should be prepared to defend on technical grounds (not based on cost-effectiveness). PM-TAC recognizes that acquisition of the entire coast is undesirable and at odds with the objectives of the master plan. Nevertheless, modeling extreme positions would provide an upper bound of the potential risk reduction costs and benefits of acquisitions and elevations. Moreover, modeling scenarios in which everyone or no one relocates at least avoids the troubled scenario of appearing to recommend the relocation of certain groups.

HIGH TIDE FLOODING DRIVE TIME ANALYSIS

The high tide flooding analysis for the 2023 Coastal Master Plan will only be conducted for a handful of selected communities. How can we use the proposed drive time analysis to communicate the impacts of future coastal change, given limited time and resources and without making the results too complex to provide clear messages? For example, should we focus on change in the next few decades or over the 50-year analysis period? Should we examine an array of facility types or a few examples in each community? Should the analysis be consistent across communities to better demonstrate patterns across the coast or tailored to the character of each community?

- The analysis of drive times and disruption by nuisance flooding was well executed, although the PM-TAC agrees with the modeling team that a focused and concise presentation of case studies will be helpful in communicating the results. The nature of nuisance flooding, or high tide flooding, is that it comes and goes intermittently, and many communities may view this as something that they can live with, by

adjusting their schedule or travel path accordingly. Further, as nuisance flooding transitions to more permanent flooding, at some point roads and highways subject to that flooding will be abandoned, with new alternatives being built, existing alternatives increasing their capacity, or communities being abandoned.

- How then should we think about the impact of high tide nuisance flooding? It is important for communities to understand and anticipate the impacts of these events on their ability to make their way to or from critical facilities for which the timing of travel cannot be adjusted. Key examples of these facilities include hospitals (either for citizens getting to the hospital, or ambulances getting to citizens), fire stations (response times will influence outcomes), schools, and potentially other sites that are community-specific. Access to these sites must be continuous, and the presence of nuisance flooding creates new, or increases existing, vulnerabilities in the community. The PM-TAC recommends focusing on a limited number of such facilities in each community being studied.
- To present the results of these travel-time calculations, maps are likely to be most effective at communicating the spatial structure, and will allow community members to "see themselves" in the results. The maps should present one metric at a time (e.g., Increase in travel time to My Hospital due to high tide flooding), but communication may be aided by maps showing roadways that are partially or completely flooded in the scenario, as this will help people to understand the travel-time results. Metrics that are directly connected to the experience of individuals will be most accessible, although novel metrics (e.g., By what year will travel time increase by X%?) may help in communications with community officials, or in developing comparisons among communities. These more complex metrics need to be used with care in general communications as they may create barriers to understanding.
- Presentations of change over the next couple of decades is likely to gain more community interest than would a full 50-year projection. However, the transition from nuisance to permanent flooding is likely to differ among communities, so the specific time horizon may need to be site-specific. Nevertheless, flood impact scenarios do not necessarily have to be tied to time horizons, and could instead be given as the change in flood impact for a given increment of sea level rise. This could help simplify the storylines, and ameliorate uncertainty in the sea level scenarios themselves.
- Additionally, each of the decisions that shape these analyses and their presentation (which facilities, what time horizon, how to present them) would benefit from community engagement and input. There may be community-specific factors, such as a singularly-dominant employer or a particular community service, that inform these decisions. The more the analyses and presentations can be co-developed, the more accessible they will be for the community.
- Finally, the nature of these calculations is that they must be site-specific, and resources will constrain how many communities can be formally analyzed. The choice of communities should be guided by the potential impacts and, perhaps, the

representativeness of a community for others in the region (i.e., if there are typologies of communities based on their road network, or the positioning of their critical facilities, representative samples from each typology could be used to illustrate the impact of nuisance flooding). Regardless of the method used to choose communities, however, it will be important to be able to clearly explain that method, so that communities know why they were (or were not) included in the formal analysis.

RISK ANALYSIS AND RAINFALL

How should changes to rainfall, and inclusion only in enclosed polders, be appropriately described and communicated? Do the rainfall changes motivate the use of multiple pumping scenarios?

- The PM-TAC recommends conducting a sensitivity study to determine how sensitive CLARA outputs are to various pumping scenarios. For example, consider simulating the 0% and 100% pumping scenarios as a way to (1) understand the range/uncertainty introduced in the CLARA outputs and (2) understand how uncertainty in pumping compares with uncertainty in other flood-hazard components (e.g., storm surge).

PM-TAC REPORT #5 ADDENDUM

DATE: 2021-09-20

RE: PREDICTIVE MODELS TECHNICAL ADVISORY COMMITTEE (PM-TAC) – AUGUST 2021 MEETING FOLLOW-UP DISCUSSION NOTES

RISK ANALYSIS AND RAINFALL

- Current approach for calculating rainfall:
  - Uses storm track, angle, etc. to estimate total rainfall over time based on the IPET model with a bias correction (developed for the Louisiana Watershed Initiative) using 14 historic storms over the last 11 years
  - Because this approach is more accurate, the CLARA team removed a cap that was added for the 2017 modeling. This resulted in significantly more rainfall (about half of the storms modeled exceed the 2017 cap) and the need to re-examine pumping scenarios.
- PM-TAC: Is the uncertainty in pumping scenario large or small relative to other uncertainties; if relatively large, can it be carried through in the analysis without rerunning all scenarios each time?
- PM-TAC: It is possible to come up with specific cases in which uncertainty would be important for Future With Action (FWA) runs (e.g., where uncertainty might bump up the relative values of nonstructural vs. structural projects) - could be considered as an additional layer in screening for the nonstructural analysis.
- Next Steps: consider 3 pumping scenarios (0%, 50%, and 100%) for FWOA runs, then revisit and determine the best path forward based on how sensitive the results are to these scenarios.

COASTAL PROTECTION AND
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POPULATION PROJECTIONS

- Clarification on approach:
    - Matt Hauer's analysis controls population projections to a Shared Socioeconomic Pathway (SSP)
    - For the 2023 Coastal Master Plan analysis, SSP 2 (related to Representative Concentration Pathway (RCP) 4.5) was used to control the Louisiana population projection, though Hauer noted he has flexibility to analyze/explore uncertainty around using other SSPs as controls
    - SSP 2 is a "middle of the road" option and was thought to be a reasonable choice when only one projection (single scenario) is being used for analysis
    - Note that for the 2017 analysis, the risk team did not see a lot of sensitivity in model output to these assumptions (which is why a single scenario is used for 2023)
- PM-TAC: Across SSPs, population growth predictions vary widely (from gain to loss) for Louisiana
    - It makes sense to adopt a middle of the road approach, and there is not necessarily a need to run other scenarios (or to look at the full range), but it is important to be able to explain what was done and why
    - If time allows, it could be interesting to look at another scenario with different patterns for rural vs. urban growth and the impacts of that on prioritization in terms of equity
        - Could be an alternative SSP for which different rates of decline lead to different ratios
- Next Steps: CPRA can get a write-up from Matt Hauer about relative trends across scenarios (e.g., urban vs. rural growth/decline)
    - If time does not allow for this analysis to be done now it could be included in additional analysis done post-2023 plan.

NONSTRUCTURAL RISK REDUCTION

- Discuss specifics of PM-TAC suggestions for bounding scenarios to explore for acquisitions and elevations, particularly the upper limits (to understand max benefit and cost even if not realistic)
    - Note that the CLARA analysis assumes that any new construction uses updated standards
    - For elevations
        - Already discussed applying 100% participation rate
        - The second part of defining an elevation threshold is determining what freeboard, year/scenario combination, and annual exceedance to use
            - Recent examples: 500-year storm elevation plus 2 ft.

freeboard (Houston); Year 50 predictions for 100-year storm elevation plus 2 ft. freeboard (Boston)
- Note that the master plan runs incorporate subsidence for relative sea level rise (RSLR)
- PM-TAC suggestion: For extreme case (upper boundary to explore), use Year 50 projections based on higher scenario for 100-year storm plus freeboard
- Discussion:
    - Anticipating this will push a lot of areas above the 14 ft. threshold
    - Note that there is not a lot of time for iteration on this, but the risk team can explore and share results
    - In addition, Year 50 elevation targets will not be available until after those runs are complete (later in the process)

- For acquisitions
    - The current approach limits acquisitions to small residential structures, so there is a question about whether (and how) to expand this to more of a "community retreat" option that includes acquisition of non-residential structures as well. Note:
        - In order to account for non-residential structures, costs would need to be developed
        - The current approach does not account for relocation within the CLARA domain (i.e., assumes people move outside of the coastal area when homes are acquired)
    - PM-TAC concern about selecting specific communities (where the question becomes 'why are you targeting us?') vs. a systematic approach looking across the coast (where the question is more about challenging values for thresholds, etc.)
        - Clarification: the purpose of the analysis is not to present results as a story in the master plan documentation, but to inform calculations within CLARA
    - What should the threshold be to trigger community wide acquisitions (whether residential only or including non-residential structures), e.g., when 50% of the structures in a community meet the flooding elevation threshold for individual acquisition?
        - Hypothesis that more communities will meet the 50% mark (e.g., Braithwaite)
        - Note that the nonstructural analysis will evaluate owner-occupied residences (vs. camp, etc.)
        - Should be interesting to look at the clustering of

communities that meet thresholds and any connections to the cause(s)

- PM-TAC: It is definitely worth investing time and energy into developing this analysis, but it should be comprehensive and careful because results could be so severe
    - Note that this is a big shift (from recommending acquisition of individual structures to community-level acquisitions); it is important to keep in mind that any acquisitions would be voluntary and that actual participation rates would vary depending on many variables that are difficult to predict, including elevation targets selected, cost share options, and available services remaining.

- Proposed next steps for the risk team:
    - Test sensitivity of the threshold for community-level acquisitions
    - Consider approaches for costing for non-residential acquisitions
        - PM-TAC suggestion to look at documentation of whole community relocations (e.g., in New York), and look at UNC research (Salvesen et al.) related to economics of community services, etc.

PM-TAC REPORT #6

DATE: 2022-04-28

RE: PREDICTIVE MODELS TECHNICAL ADVISORY COMMITTEE (PM-TAC) – MARCH 2022 MEETING REPORT

PM-TAC MEMBERS

- Jen Irish - Virginia Tech, Civil & Environmental Engineering, Center for Coastal Studies
- Courtney Harris - Virginia Institute of Marine Science, Department of Physical Sciences
- Wim Kimmerer - San Francisco State, Estuary and Ocean Science Center
- Matt Kirwan - Virginia Institute of Marine Science, Department of Physical Sciences
- A. R. Siders – University of Delaware, Disaster Research Center
- Mark Stacey - UC Berkeley, Department of Civil and Environmental Engineering

OVERALL COMMENTS FROM PM-TAC

- As noted in prior reports, the PM-TAC continues to be impressed with the comprehensive and thoughtful approach being taken by the CPRA team in this Master Planning process.

RISK OUTPUTS

- The PM-TAC recommends that CPRA compare EAD$ and EASD with discrete census variables.
    - The PM-TAC recommends against using social vulnerability and environmental justice indices (e.g., SOVI, EJ screening). Instead, the PM-TAC recommends evaluation with respect to the following eight discrete census variables: (1) race, (2) income*, (3) poverty rate, (4) renters vs. owners, (5)

elderly, (6) disability, (7) home value, and (8) population density. Some of these metrics may be redundant, but these represent a starting point from which CPRA can narrow down. The PM-TAC recommends using census data as overlays on Master Plan risk outputs in order to better understand how different groups might be affected by projects.

- This approach is supported by academic literature that says that when people fall into particular demographic groups, it affects how they experience disasters and their ability to respond to a disaster.
- These data could be helpful to analyze in particular for those groups under the EAD$/EASD trend line.
- * It is challenging to select a metric for income (such as poverty rates, LMI [Low and Moderate Income], below state median, quartiles / quintiles) that will be universally accepted. The PM-TAC recommends CPRA select an income metric that is higher than the poverty rate in order to capture a larger percent of the population. If the primary purpose is to communicate that CPRA is not only protecting the very rich, median income might be a good choice. Another option is LMI; because it is a HUD grant requirement, LMI might be an easy place to align indicators if CPRA is informing communities and they use that information, e.g., to apply for grant money.

- The PM-TAC suggests that CPRA consider comparisons between and within communities. For example, are certain groups disproportionately affected? Such analyses might be performed at the Census block level and then aggregated to community level for reporting.
    - PM-TAC recommends first looking at each census variable separately to see what drives the divergence between the EAD$ vs. EASD calculations, then considering various AND and OR combinations of variables. CPRA might consider color-coding the EAD$ vs EASD plot based on each census variable in order to evaluate and visualize how the divergence differs among census variables.
    - For analysis of inequities in exposures and vulnerabilities within communities, the following paper may be relevant (although it was not written with equity as a specific focus): Hummel, M. A., Wood, N. J., Schweikert, A., Stacey, M. T., Jones, J., Barnard, P. L., & Erikson, L. (2018). Clusters of community exposure to coastal flooding hazards based on storm and sea level rise scenarios—implications for adaptation networks in the San Francisco Bay region. Regional Environmental Change, 18(5), 1343-1355.
    - If such an analysis is not feasible within the current Master Plan timeline, the PM-TAC recommends that this type of analysis be included in the next Master Plan cycle.
- The PM-TAC recommends CPRA consider the following in future Master Plan cycles:

    - Development of specific environmental justice goals in future iterations of the Master Plan. In this case, Census variables may be used to assess how planning tool outcomes meet the stated goals.
    - More rigorous evaluation of feedback among population projections and other policy recommendations and risk.
- When it comes to communicating risk outputs, the PM-TAC recommends:
    - Emphasizing that the Master Plan's risk outcomes are primarily a tool to inform policy decisions about who and what to protect (e.g., whether to protect commercial or residential assets).
        - For example, the risk outputs might suggest that a good place to focus investments from a social justice standpoint is in places that have historically been underinvested in. For example, evidence in Texas suggests some geographic areas were more vulnerable to some particular outcome than others because previous infrastructure investments had been focused on other areas. (See this example of one town in Texas that reprioritized flood management funds explicitly to address historical disinvestment and racial disparity: https://www.nytimes.com/2020/07/24/climate/houston-flooding-race.html)
    - Emphasizing that risk outputs do not account for future decisions by locals, e.g., where new housing will be built. Communicate that there are lots of things that local governments/communities can do to reduce future risk, and remind people that there is a huge piece of the protection puzzle outside of CPRA's purview in the current Master Plan process – zoning, building codes, land use, housing authorities. (See, for example, this 2022 study that concludes that the location of population growth could affect flood risk four times more than climate change: Wing, O. E., Lehman, W., Bates, P. D., Sampson, C. C., Quinn, N., Smith, A. M., ... & Kousky, C. (2022). Inequitable patterns of US flood risk in the Anthropocene. Nature Climate Change, 12(2), 156-162.
- The PM-TAC was very impressed with the quality of both content and visual presentation within the Risk Tableau interface.
    - For additional clarity and interpretation, the PM-TAC recommends adding a consistent reference line to the EAD$/EASD correlation tab to better enable comparison as different options are selected, in addition to the trend line shown. CPRA might also consider fixing the x and y axes between figures to aid in comparison of differing trend lines.

FUTURE MODEL IMPROVEMENTS VS. ADDITIONAL EXPLORATORY DESIGN: RISK

Barrier Islands:

- The PM-TAC appreciates that CPRA has significantly advanced understanding of the role of barrier islands in the Master Planning process, and acknowledges that a null result is an important result. Based on this null result, the PM-TAC agrees that it is not worth further developing the model (e.g., with an improved representation of the physics) and sensitivity testing if the underlying model does not address the Master Plan team's needs.
- For the next Master Plan, the PM-TAC recommends evaluating barrier island scenarios using a bounding approach, i.e., exploring extremes instead of making predictions. If these bounding scenarios reveal that there is little or no sensitivity to barrier island states in subsequent risk calculations, the barrier-islands analyses could be scaled back or eliminated. The bounding approach could proceed as follows:
    - Run ADCIRC with barrier islands for two scenarios: (1) degraded to the point of being restored and (2) recently restored. If the difference in model output between restored and degraded barrier islands is small, barrier islands will have little effect on risk outputs, and further development of the models is unwarranted.
    - There may be only a few instances where more detailed analysis is needed to determine where islands get restored. For a few communities there might be a lot of sensitivity, but an overall analysis might rule out 95% of the islands from the need for further analysis.
    - PM-TAC recommends investing effort instead in evaluating those few barrier islands whose state of degradation may impose a measurable impact on risk to nearby communities.
        - Consider a range of different states the islands could be in, and consider handling barrier island restoration status in uncertainty analysis.
        - Consider accounting for within-storm breaching and overwash empirically, similar to the treatment of levees.
        - The observation that a small number of barrier islands may have an impact on storm surge impacts motivates considering high-resolution surge modeling of those sites to clearly define the impact of those islands on risk outcomes.
        - The PM-TAC noted that the use of historical rates of marsh edge erosion makes sense for barrier islands far offshore, but recommends CPRA revisit and potentially update marsh-edge erosion rates for islands closer to the mainland that are identified in

the analysis described above as affecting risk estimates.

Compound flooding:

- The PM-TAC agrees that compound flooding is a significant and important process and appreciated the opportunity to learn more about recent scientific and methodological advances in this area. As a general principle, CPRA in its planning activities should focus on implementing best current-practice modeling strategies and should not implement a modeling strategy that is not vetted and operational. Thus, the PM-TAC sees no need to implement anything additional for the 2023 Master Plan beyond what is already being implemented for tropical cyclone precipitation and for polders.
- Given the novelty and evolution of the Louisiana Watershed Initiative's (LWI) work, the PM-TAC thinks it is too early to say if a new inland-to-coastal flood modeling framework could be implemented for the 2029 Coastal Master Plan.
    - PM-TAC recommends continuing to keep communication open between LWI and CPRA.
    - PM-TAC recommends that, for the 2029 Coastal Master Plan, at a minimum the CPRA should:
        - Account for compound flooding in terms of bias characterization, and
        - Extend what CPRA is already doing for polders for non-tropical storms.

Risk Characterization with CLARA:

- The PM-TAC agrees that CLARA is an appropriate tool for master plan level analysis, and should be continued in the 2029 Coastal Master Plan. The PM-TAC recommends focusing on developing CLARA to be efficient enough to run a large number of alternatives.

FUTURE MODEL IMPROVEMENTS VS. ADDITIONAL EXPLORATORY DESIGN: RESTORATION

- For the 2029 Coastal Master Plan, the PM-TAC recommends that CPRA focus primarily on ICM modeling efficiencies.
- The value of the 1D channels/routing appears to have limited utility, but is dominating the runtimes. PM-TAC recommends only keeping the 1D channels that create a notable impact and removing the others.
- The PM-TAC noted that marsh erosion rates are reasonably captured by constant rates, but for the 2029 Coastal Master Plan, CPRA might consider varying erosion rates by vegetation type (including change of rate when vegetation type changes).
- As a secondary focus in the 2029 Coastal Master Plan, CPRA might consider a low-

resolution version of the ICM to support a global structural sensitivity analysis. This would be useful for exploring where future model improvements might be most influential.

- The PM-TAC notes that an advantage of thinking in terms of where to implement projects (vs. what projects) that will make a difference is that the information could be used to identify where more nuanced models may be needed, then identify models available that fit these need(s).

FUTURE IMPROVEMENTS: OVERALL

- For the 2029 Coastal Master Plan, the PM-TAC recommends that CPRA focus on having an efficient suite of tools to address the two objectives and audiences: (1) help decision-makers determine which projects are funded within budget, and (2) support conversations that empower community action and help communities make their own informed decisions. The PM-TAC thinks it will help to make these two sets of objectives and audiences more distinct.
- For the 2029 Coastal Master Plan, the PM-TAC recommends that CPRA focus on integrating the various modeling components from ICM through CLARA and on developing a modeling framework that is computationally efficient enough to be used to evaluate a large number of scenarios and project alternatives.
    - Across most modeling components, the PM-TAC recommends CPRA focus effort on integration and computational efficiency rather than on improving or expanding specific models for added incremental accuracy.
    - PM-TAC recommends CPRA explore the inclusion of feedback. As two examples of how these feedbacks might be included:
        - To better characterize the impact of population growth on damage, the team might consider a scenario that assumes the new population occupies only the least exposed areas; or that population growth reflects new buildings that are all elevated far above flood heights.
        - The modeling framework might consider how land eroding away impacts the presence or removal of infrastructure.
- The PM-TAC thinks that one of the most innovative next steps CPRA can take in the 2029 Coastal Master Planning process is to assess land use and its effect on risk outcomes. For the 2029 Coastal Master Plan, the PM-TAC recommends that CPRA consider conceptual land use planning scenarios, namely bounding scenarios as follows:
    - If the modeling framework can be made really efficient, land use scenarios might be considered in a manner similar to how climate scenarios are considered.
    - As an upper bound scenario, CPRA could assume that every coastal parish adopted International Building Codes and best land use practices.

Acknowledging that such a scenario is unrealistic, it will be useful to see how sensitive risk outcomes are to this upper bound scenario.
    - Such scenario or sensitivity analysis may be used to show local governments that land use planning can reduce future risk. For example, if the plan assumes that a population grows, communities are going to need new housing and can decide where those get built. This is important because local governments have control over land use, in contrast to other elements controlled at the State and Federal level (e.g., levee upgrades).
- For the 2029 Coastal Master Plan, the PM-TAC suggests that CPRA consider how to use the models to identify how to design a series of actions or projects that would achieve the greatest delay in extensive land loss. The current modeling capability was developed to evaluate projects conceived outside the modeling group. An alternative would be to use the model suite in a proactive, e.g., to develop projects that would make a difference, or even optimization mode. This would require rethinking how the models are used, as well as the improvements suggested above.
- With regard to CPRA's proposal to adjust the structure of analysis for the 2029 Coastal Master Plan: The PM-TAC agrees that it is exciting to think about reversing the analysis process, intellectually and academically, but there are concerns that this approach might decouple coproduction of knowledge and community engagement. If CPRA decides to take this new approach, the PM-TAC recommends taking steps to minimize negative impacts on coproduction and engagement, such as:
    - Adding an additional step after project evaluation (e.g., with Regional Workgroups (RWs)) to foster coproduction, namely facilitating discussions around results once projects are evaluated.
    - Consider scheduling time within the 2029 Coastal Master Plan process for evaluating and reiterating to assess how to make projects more effective. Consider ways to make this iterative step really fast by using a lookup table.
        - For example, interpolate between discrete results for land building, EAD$, and EASD in order to estimate results for interim or combinations of projects falling within the bounds of the discrete results. Or, other methods by which complete reruns of the ICM and ADCIRC would not be necessary in order to evaluate new alternatives.
    - Consider ways to buffer the concern that people who live in an area are not involved in deciding what the best solutions are in that area.

PM-TAC REPORT #7

DATE: 2022-11-11

RE: PREDICTIVE MODELS TECHNICAL ADVISORY COMMITTEE (PM-TAC) – SEPTEMBER 2022 MEETING REPORT

1.1 PM-TAC MEMBERS

- Jen Irish - Virginia Tech, Civil & Environmental Engineering, Center for Coastal Studies
- Courtney Harris - Virginia Institute of Marine Science, Department of Physical Sciences
- Wim Kimmerer - San Francisco State, Estuary and Ocean Science Center (unable to attend)
- Matt Kirwan - Virginia Institute of Marine Science, Department of Physical Sciences
- A. R. Siders – University of Delaware, Disaster Research Center
- Mark Stacey - UC Berkeley, Department of Civil and Environmental Engineering

1.2 QA/QC PORTAL IMPROVEMENTS FOR 2029 MASTER PLAN

- The PM-TAC agreed that the QA/QC portal as implemented for the 2023 Coastal Master Plan is an excellent tool for efficient QA/QC, and it represents a very significant advancement over the procedures used in past master plans.
- With regard to future improvements to the QA/QC portal for implementation in future planning cycles, the PM-TAC recommends that CPRA capitalize on the success of the QA/QC portal by developing a list of additional functions needed to support not only QA/QC but analysis in general, then prioritize this list for implementation during the 2029 master planning cycle. The PM-TAC recommends CPRA consider the following:
    - Prioritize the inclusion of more geospatial representation and related functionality.
    - Given the potential for CPRA-use beyond QA/QC, add a flag feature for

QA/QC and a bookmark feature for additional analysis.

1.3 PROJECT DEVELOPMENT DATABASE (PDD) IMPROVEMENTS FOR 2029 COASTAL MASTER PLAN

- The PM-TAC was impressed with the PDD and noted that the database represents a significant improvement over what had been done in past master planning cycles. The PM-TAC does not have any specific recommendations for future improvements to support the 2029 planning cycle.

1.4 OPPORTUNITIES TO IMPROVE RISK EVALUATION OPTIONS FOR THE 2029 COASTAL MASTER PLAN

- The PM-TAC recognizes the significant accomplishments and now relative maturity of CPRA's capacity to evaluate coastal flooding, land loss, and direct economic damage in support of quantification of future risk to support decision making. In contrast, there is a significant opportunity to advance characterization and evaluation of socioeconomic components to enable a more holistic evaluation of future risk in support of more just decisions making. The PM-TAC recommends CPRA focus on
    - Improving and integrating socioeconomic modeling.
    - Developing an approach for accounting for equity in a more structured way.
    - Equity could also be an overarching goal for the master plan (similar to preserving working coasts) so that final project selections would be evaluated for compliance with that goal. The PM-TAC recognizes that this may require decisions not made by CPRA, but CPRA could raise the issues with others.
    - Expanding the range of socioeconomic scenarios considered during the planning process. Specifically, evaluate damage assessments under an array of possible future policy and/or land use states.
    - The PM-TAC notes steps already taken by CPRA members to examine whether project suites disproportionately aid or harm demographic groups, and this approach could be expanded.

1.5 INTEGRATION OF RISK AND RESTORATION PROJECTS AND BENEFITS

- The PM-TAC agrees that there should be integration of ecosystem restoration and risk (structural, nonstructural, policy) projects and benefits and that this should be a priority for the 2029 planning cycle. Tools that enable comparisons across project types will be useful. The PM-TAC recommends we dedicate discussion time to this topic during the PM-TAC's spring 2023 meeting (mentioned below).

1.6 OTHER: RECOMMENDATIONS FOR CURRENT 2023 COASTAL MASTER PLAN

- Project selection:
    - The PM-TAC suggests that, at a minimum, socioeconomic factors could be used as a determining factor when selecting smaller, budget filler projects.
- Master Plan Data Viewer (MPDV)
    - The PM-TAC were highly impressed with the MPDV and its capacity to support communication with a variety of stakeholders and interested parties. As CPRA rolls out the 2023 MPDV to the public, the PM-TAC notes that communication and training will be very important for public users.
        - Have a planned, intentional roll-out for communication, making use of focus groups to understand how the visualization products will be used and interpreted.
        - Consider connecting with climate communication groups for assistance with and lessons learned on communicating with and training journalists on use of datasets such as the MPDV.
        - The PM-TAC suggests that the MPDV prominently display the year and scenario (not only in a pop up) so that if the text box is minimized this information still appears in screenshots. Specifically, the PM-TAC recommends that the year, environmental scenario, and "LA 2023 MP" be included in the legend so that this information will appear whenever images are used

1.7 OTHER: SUGGESTED TOPICS FOR THE REMAINING PM-TAC WEBINAR AND MEETING

- Overall approach (decision-making framework):
    - The PM-TAC recommends CPRA consider an approach using adaptive pathways as a lens for the 2029 plan, and recommends a discussion on this topic during the spring 2023 meeting, to include:
        - Opportunities for messaging to the public from a different perspective (e.g., presenting results in terms of SLR amount instead of in terms of time).
        - Addressing concerns and practicalities related to (1) construction/restoration implementation that is consistent with the master plan (i.e., if a "project" is not on the plan, it is not invested in). (2) Maintaining public and Louisiana government confidence in the master planning process while making advances.
        - Identification of and communication around circumstances in which the state might deviate from the master plan.
- Project type and benefit integration/interaction:
    - The PM-TAC agrees with CPRA that a priority advance for the 2029 planning cycle is pursuing integration of risk and restoration benefits, and recommends a discussion on this topic during the spring 2023 meeting, to include:

        - The use of project scenarios to include multiple combinations of ecosystem restoration, structural, nonstructural (built), nonstructural (policy) projects, and future socioeconomic conditions.
        - The development of an integrated decision framework that accounts for multiple objectives and multiple types of benefits.

- New model development:
    - The PM-TAC agrees that approaches to build out and expand socioeconomics impact analyses–to include equity and social justice issues–should be given priority as this is the area with most potential for positive impact on the master plan. In particular, the PM-TAC recommends CPRA consider how equity can be included in a more structured way in the 2029 plan. The PM-TAC recommends a discussion on this topic during the spring 2023 meeting.
- Scenarios
    - The PM-TAC recommends that CPRA consider a broader range of scenarios during the 2029 planning process, considering approaches to scenario development that consider future land use/regulatory conditions (i.e., modeling impacts of different policy), environmental (e.g., SLR, storm time series), population migration and building stock, and sediment supply. An approach to constructing and prioritizing scenarios would need to be developed. The PM-TAC recommends a discussion on this topic during the spring 2023 meeting.
- Existing model implementation/efficiencies:
    - Much of the existing model components and frameworks established within the CPRA master planning process are scientifically sound and mature. The PM-TAC recommends that CPRA continue to consider approaches to make these established model components/frameworks more efficient (e.g., surrogate modeling) and/or only as accurate as needed for project selection and decision-making. The PM-TAC recommends this topic as a candidate for webinar/remote discussion.
- Communication:
    - The PM-TAC recommends communication of outcomes be an area of emphasis during the 2029 planning cycle and recommends some spring 2023 meeting discussion time be dedicated to the topic of communication in a way that is effective for policy- and decision-making, and to other various stakeholders.