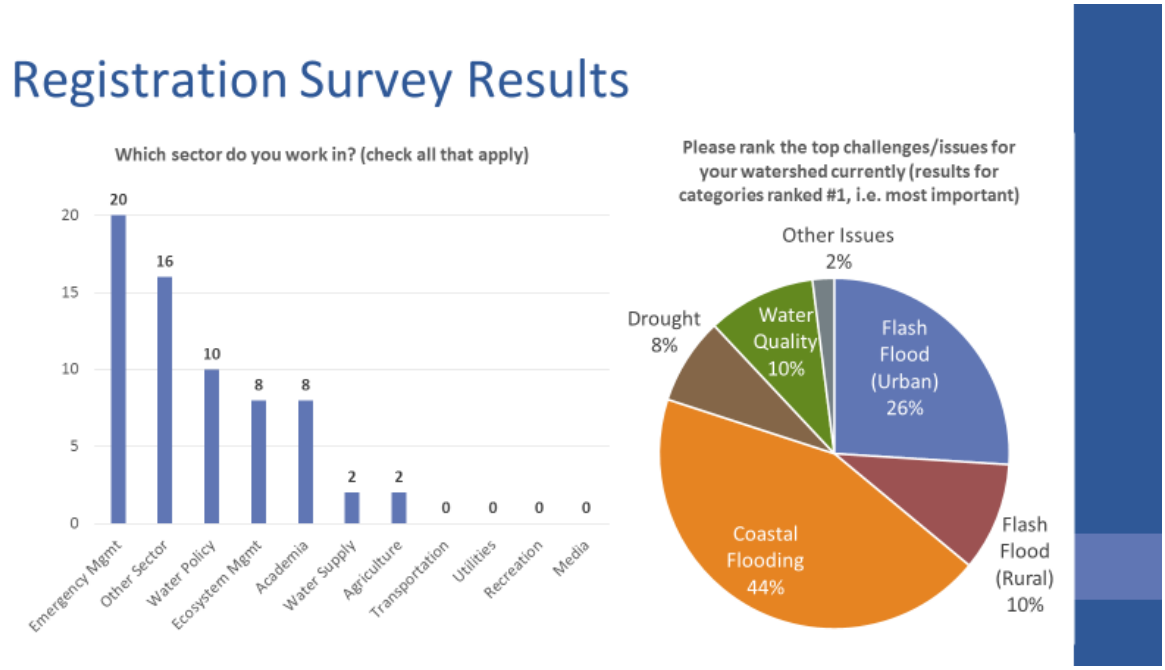
Coastal North Carolina Stakeholder Engagement– Draft Notes

June 21, 2017

Regional/Local Priority Issues Session

Registration Survey Results

Arleen O'Donnell presented results of the participant poll, which characterized the sectors represented at the meeting, and their perspectives and priority challenges (both currently and in the future).



Panel Discussion

Thomas Langan, Engineering Supervisor, North Carolina Floodplain Mapping Program

Tom discussed the use of the North Carolina Flood Inundation Mapping and Alert Network (FIMAN) (NC Flood Mapping Program) – a website that provides rain and stage gage data, flood inundation maps, flooding impacts and alerts in real-time to support risk-based decisions regarding flooding across the state. It was an important tool used during Hurricane Matthew. Tom discussed some of the products and services that are currently coming from FIMAN and also described applications during Matthew:

- Customized analyses: these were useful for swift water rescues because FIMAN can identify specific street addresses of where people need help.
- Evaluation of emergency shelter locations: Windsor was a good example of a town where emergency shelter location had to be moved based on analysis.
- Assistance in identifying evacuations and road closures for DOT: Traveler Information Management System (TIMS).
- State highway patrol: used FIMAN to position resources and operations, moving downstream as event progressed

- Air National Guard: helped determine where to take aerial photographs. FIMAN website showed where buildings were flooded; coordinates used to capture the imagery.
- QPF and QPE (pulled from WPC) prior to event: 24-hour precipitation totals were converted into time series and reoccurrence interval (used script). Another way to communicate magnitude of flooding.

Tom also mentioned a few needs/gaps, including:

- The National Water Model (NWM) needs to be calibrated and validated for North Carolina and leveraged for FIMAN.
- RFC gage sites need to be added (sooner than NWM).
- 24 QPF needs to be improved since used operationally. Even order of magnitude would help.
- SLOSH hindcast for damage assessments would be helpful. How high and where inundation will occur. Boundary from hindcast is needed as well.
- Satellite data is needed at higher resolution and on a daily basis.

Dianne Curtis, Eastern Branch Manager NC Emergency Management (NCEM)

Dianne described her experience working with local emergency managers during Hurricane Matthew, the unique challenges faced in Eastern North Carolina, as well as some of the Eastern Branch's needs.

- The main customers are EMs at county level. They have to make the important decisions like evacuations, etc. - these are the end users. There is also pressure from elected officials during each event.
- Information NCEM gets from SERFC, NWS, NHC, is critical. But some locals cannot interpret it so translating meteorological data is important part of their job. NCEM does its best to push the same consistent, messages through social media and whatever it sends down to local EMs.
- Eastern North Carolina deals with three types of flooding: flash flooding, riverine flooding, and sound side flooding. With the sound-side flooding, the Outer Banks can become totally cut off.
- With Hurricane Matthew, NCEM knew the amount of water coming - knew it would be like Floyd. But the water did not go to the same places, which was challenging. NCEM knew Lenoir County would get cut in half by the Neuse River. But delivery of medical, food, other services was still successfully planned. Lenoir was prepared – they set up their own medical services.
- During Matthew, the planning for the high water went really well. But EMs have no easy task – they are very often making gut decisions.
- 103 families are still in recovery (8 months later).

Gaps, needs, and challenges in Eastern North Carolina:

- There are gage gaps, especially in Windsor. Even some locals are purchasing gages now. There are sound side flooding gaging gaps too. Great forecasting, but no hard gage data.
- Working with Corps to improve education of public and messaging. When the east floods, the public fears that "flood gates are being opened" upstream and flooding is made worse.
- Language of "turn around don't drown" does not appeal or work for the younger generations.
- Fatalities were avoidable during Matthew. Translating to the public the dangers is the challenge.
- Hurricane Rita message was along the lines of "get off the roads or you'll die." Maybe escalating the language is necessary?

Participants during plenary session

Allen Everette, Emergency Management Director, Pitt County

Allen described his experiences in planning for and managing resources during Hurricane Matthew. He discussed challenges and need/gaps from the emergency management perspective.

- In 1999, during Floyd, Allen was a fire marshal at the time and experienced 29 feet of water in Pitt County.
- For Hurricane Matthew, the forecast was changing. Started getting predictions of 26 feet, which would mean the flooding would sever the county – this was what EMs prepared for.
- EM objective is protecting community, but there are also always political pressures.
- Pitt County hosts a 20+ county Trauma Center and therefore EM Department has to plan for people going there to be treated – that was a major challenge. How to keep the community operating. How to keep people able to get from point A to point B.
- Pitt County ended up receiving 24.5 feet, which did not quite sever the county as anticipated.
- Lack of river gages is a problem – forced to use data from way upstream.
- Need to consider getting gages along Tar River and also southern Pitt County creeks – Grifton Community. Grifton flooded during Matthew and the community wants to know why there are no gages closer to Pitt County.
- April floods: something about the idea that "gates are being opened" by the Corps creates a political nightmare. Citizens call elected officials, they call EMs, Eastern branch – need to educate community when gate is open and water released.
- In southern Pitt County there are definite coastal coupling issues. Gage is to the west in Green County (15 miles away). Water levels got higher after water fell in Snow Hill because the water was getting backed up.

Holly White, Principal Planner, Town of Nags Head

Holly explained the many considerations required when preparing for events at the local level on the Outer Banks of North Carolina.

- The Town of Nags Head uses information to position preparation for the storm. Planning and Development Department works in tandem with Building Inspections Department.
- Need to find out: Do we have damaged structures? What was high water mark? From storm surge modeling to predictive rainfall events, town government takes all this into account.
- Important decisions need to be made, e.g., when to evacuate hospital in Nags Head.
- Matthew was unique because it was not a storm surge event (Nags Head experiences surge from the sound side or ocean side depending on track of storm). With Matthew, the town received 12 inches of rain in 4-5 hour span.
- There was a lot of rainfall ahead of the Matthew and the water table was already elevated when Matthew hit (due to rainfall). Water table is naturally high along the coast.
- Barrier island systems create ponding due to frontal dunes on ocean side and relict dunes in back. Not a lot of filling happening in town, which means no opportunity to raise elevation. Experienced 1.5 - 3 feet of standing water due to natural topography and rainfall.
- There are open swale ditches, and outfall pipes can drain, but due to high tides the flapper valve would not open until tide went down and town experienced bathtub effect. Town had standing water for 3 or 4 days before drained out. Nags Head, Kill Devil Hills, and Kitty Hawk all experienced similar flooding.
- Water quality is a large issue because most of the Outer Banks are serviced by septic - 80% of Nags Head is on septic systems. When you have several feet of standing water over septic for 3 days – how does that impact water quality? Storms passed, people on the beach the next day. Wading through standing water to get there.
- Hurricane Irene (2011) experienced similar flooding, but there were not enough gages along the Sound to fully understand this event. Need better grasp on groundwater fluctuations.
- Town is in the process of looking at sea level rise (Jess Whitehead). How does it affect flooding, water quality, etc.
- It would be helpful to have storm follow-up, maybe regional meeting. Invite town managers, damage assessment teams so that everyone can better understand where there was water, how high was the water, etc. Share historical flooding. Then the town can start to develop regulations based on this information.
- Improvements have been made in local elevation for newer construction. Found the newer homes constructed experienced fewer impacts.

Panel Q & A and General Comments/Other Shared Experiences

- Q: Everyone is mentioning need for gages, but gages cannot tell the forecast, it has to be predicted based on models. Do we need more information on current state or on what is going to happen?
    - We need both. History will help us, but also for moment in time.
    - You lose flooding information so quickly without satellite imagery; post-event inundation boundary would be helpful. Need both.

    - If we're using gages, we're going to have to assume worst case and that we are using the Rocky Mount gage. If closer, we may not need to spend resources.
    - With NWM there will be 2 million plus stream reaches with forecasts. That will provide information in a lot more locations even without gages there. Like when NWS gives forecast, you will not go to the observation point, you will get a map of information made locally for you.
    - There are very few gages along the sound side.
    - Not an either or, but understanding what critical products are.
- For Hurricane Joaquin, there were no gages in Brunswick County. This county gets the highest amount of precipitation in the state.
- In Hyde County, on the outer coastal plain, there can be so much rainfall with nowhere to go and no gages communicating that information. It is challenging because people do not understand why water is not running off. It is very different than riverine flooding.
- How to forecast total water level? Need gages to validate models.
- USGS has 3-pronged approach to hydrologic data collection. They have 260+ riverine gages in NC, with many in the coastal plain. But with recent hurricanes, they are now putting out rapid deployment gages, e.g., 10 gages out during Matthew. 150 locations in coastal NC where USGS put out non real time sensors to monitor storm surge. After-the-fact, the data is collected (e.g., high water marks) and provided to public. These data get incorporated into FIMAN.
- Q: once flooding gone, what is the inclination to stay? People are aware they are at risk?
    - It is a mixed bag. Mostly has to do with insurance and funding – Nags Head applies for mitigation type funds. FEMA money comes into the state and then out to local communities.
    - Also generational way of thinking and people are willing to accept the risk as part of living there.
    - Many homes are rentals/owned by people from out of state and the dunes give a false sense of safety.

Rotation Stations

Inundation

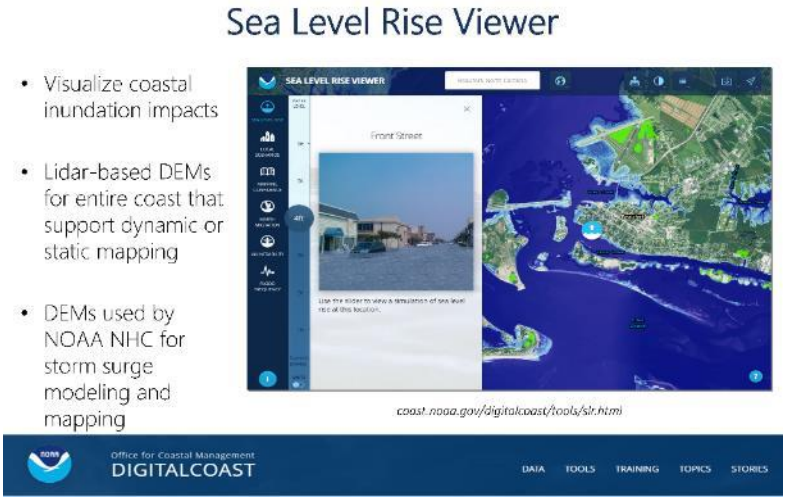
Presentations of all inundation posters and live demonstration:

Sea Level Rise Viewer

- Explanation of data visualization tool – simulation of water levels, affected areas.
- Layer with FEMA flood zones and other hazards layers on potentially affected areas.
- Lidar based DEMs.

Hurricane Center –Coastal Storm Surge products

- Long term planning guidance – SLOSH



Model.

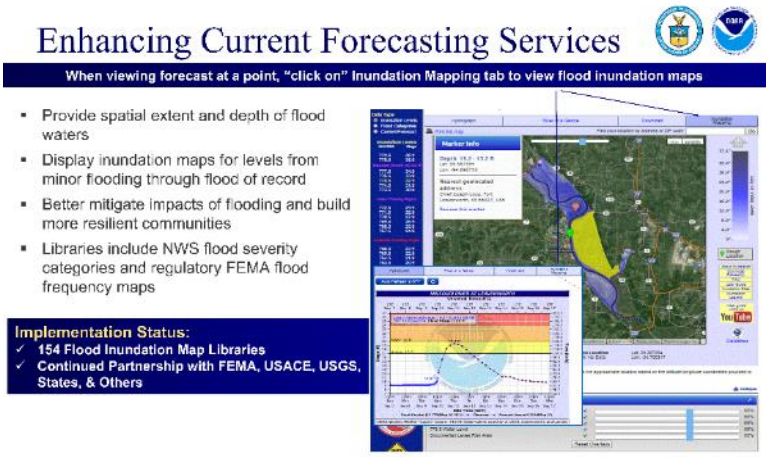
- Real time guidance – hurricane track and intensity.
- P-Surge (probabilistic)
- P-Surge with elevation data – potential storm surge flooding maps.

Inundation Maps from NOAA's Map Library

- Library of previous floods, users can build scenarios – how NWS currently builds scenarios.
- Total water level analysis is expensive and intensive to create the coastal coupling component.

NWM inundation products (live demonstration)

- Simulation of inundation map for Hurricane Matthew.
- Official NWS forecast comes from WFOs and RFCs. This information should augment the official forecast info.
- Maps are distributed to RFCs and WFOs and those staff decide whether to share this info with local core partners.



Questions/Comments

Sea Level Rise Viewer

- Relative to MHW, it would be more useful to actual elevation or specific elevation. Option to display in a different datum.
    - NHC hears that a lot. Communicating different datums is difficult.
    - Noted that uses and degrees of sophistication differ.

Hurricane Center –Coastal Storm Surge products

- P Surge – using the 10% probability. Any plan to use a different probability percentage (maybe 50%)? It would be helpful to have a more accurate GIS layer for probability of surge.
- To understand how useful it is – how much are you integrating reservoir operations? That is critical. Public perception of reservoir flooding – need to try and best understand the reservoir behavior during inundation.
    - Does not include regulated flow. NHC is working on regulated flows and trying to incorporate USACE data into the models, but that will take some time. There is a chance that Corps data will eventually be incorporated but non-Corps regulated flow – no immediate plans for that right now.
- Also issues with wastewater discharges during high flow events. And critical to know how the salinity front moves.
    - Yes, understand that is a priority on the WQ side.
- Water levels in the estuary – hard to model.
    - NWM can be used as inputs to local modeling of estuary for inundation.
- We don't have any gage data – what do we need?

- Can maybe get that from tidal datums. NC has full Lidar data for the entire state (QL2).
- NOAA has V Datum Model for coastal inundation – translates tidal datums to orthometric (land based) files.
- Layer that can be used from ADCIRC Model.

NWM inundation products (live demonstration)

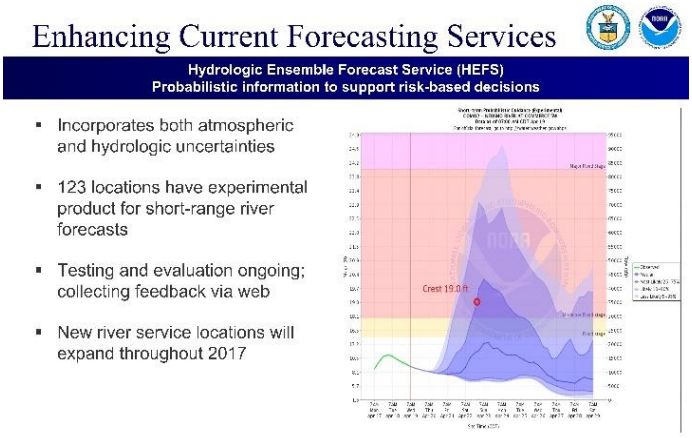
- How did the NWM do with Matthew?
  - It did OK, but all is experimental.
- Who is the audience? Professionals?
  - This guidance will go to WFO and RFC. They will make a strategic partner to share this info with core partners.
  - Some people agree that it's a fine approach. Info is more nuanced.
  - Emergency Manager: Not sharing map because it could create anxiety? A visual aid to the community – from EMA perspective – it's OK to cause fear so that people understand the urgency/potential harm.
  - NOAA does not make decisions about how the local community will respond.
- Is there concern that the NWM would be too specific or would it be billed as a "worst case scenario" and incorporates uncertainty.
  - In perfect world NWS would run this model with ensemble (i.e., worst case through not the worst case). The way you would think about this is guidance to say – look here at potential "hot spots" or areas that could be more flood prone.
  - Model is only as good as the precipitation forecast. Forecast is still critical.
- Thinking back on Matthew – where is the inundation and how deep is it.
  - NWS/NWM is working on getting the depth (height above drainage). How can we work with local partners?
  - Implement with layers – bridges, evacuation routes, hospitals, schools (shelters), critical infrastructure, water/wastewater.
- You can use the NWM with your own GIS.
  - Yes, that's the idea. Worried about users who might not that capacity.
- Would this be complete for the whole river basin to the mouth/sound?
  - Right now only available from the river basin to gage. Working on the coupling now but note that you will then need to work locally to decide what model is most appropriate to use.
- As you get to the coast – get closer to levees and other regulated flows.
  - Yes, working on incorporating flooding from regulated flows.
- How often would you produce this map?
  - It would be generated hourly and each time shows map.
  - 250-meter resolution and in some cases down to 10 meter resolution and shows you 18 hours out.
  - Can get this map 30 days 15 days and 8 hours out.
- HRRR drives the 19-hour forecast and we use 6 support models and working on HND (height above nearest drainage) to ultimately look at extent and depth.
- How do you reconcile no coupling?
  - We are eventually going to build a hydraulic model that combines NWM with say ADCIRC to get the coupling.
- How do you communicate uncertainty?
  - In theory, we would run the NWM as an ensemble, but at the moment we cannot do

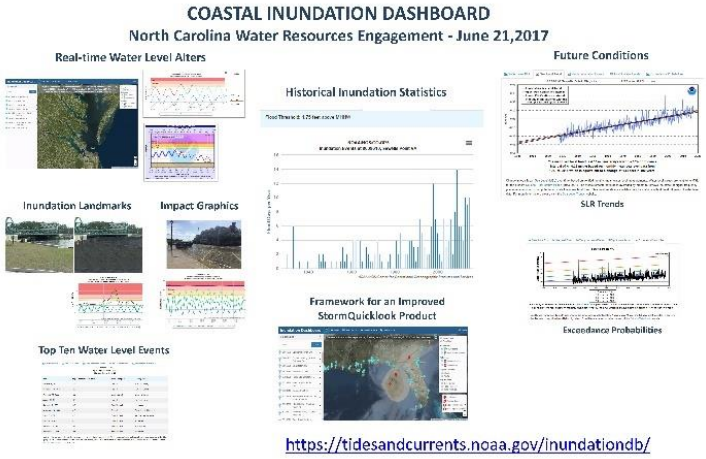
that. So starting with deterministic model not probabilistic. And again, this is guidance and local managers need to decide who gets this information and if it's even used as the primary method of analysis.

- How do you validate the inundation?
    - Remote sensing, aerial extents (sensitivity analysis)
    - Possibly crowd sourcing (e.g., Norfolk work) and provides ground truthing and can be kept in a library.
- How does this be compared to NC's FIMAN system?
    - We would take it and use it as water surface elevation to better understand where the water is and what assets it impacts. Hopefully we could map in between gages.
- Will the maps be available for the whole river?
    - Yes, not just at gages.
    - At a future date, we can have a hydrograph for every area.
- How can we really validate the inundation? And have you identified areas in the country that need more data beyond the current data?
    - We are talking about what is the National Observation Strategy to validate the data.
    - Definitely need to make sure that local and other agency data is shared with the National Water Model.
    - Yes, all of the NC new gage data are shared with the NWS.
- Where have you encountered problems with GIS data?
    - Simply knowing the data exist is a problem.
    - Sounds like it would be working similarly to FIMAN and that system is working well on the ground – EMAs are calling to say at what point do we need to relocate these people.
    - States might be a good level for that decision making.
    - NWM will help other states to build what NC has in FIMAN.
- How do we do probabilistic in the Basin?
    - NWS cannot build those tools in the Basin. Local partners need to build that.
- Only Emergency Manager can decide if/what information is disseminated to the public.
- Media issues – NWS is trying to work with media focus groups on this issue.
- Add tabs for QPF and Surge – can you integrate that into NWM?
    - That information is available but no plans to have it in the interface.

Streamflow and Tides

The Streamflow and Tides station included a demonstration of a streamflow anomaly service/product that may be available in the future from the National Water Model, a presentation on the National Ocean Service Dashboard, and presentations and discussions around uncertainty products and services (HES, AHPS).





Questions/Comments

Stream anomaly services/ products (live demonstration)

Questions

- Very high means what? Need more info that it is “Very High” flow potential
- How to communicate a rapidly changing situation, FFW in effect but a dam breaks so how do you message the new threat?
- How did people view FFW vs FFW Emergency?
    - There are complexities with trying to communicate this through Army forecasts - with Hurricane Matthew example.
- There is a need for comparing precipitation to normal, not just streamflow to normal. Can we do it with rainfall as well?
- How will public use this product? How about broadcast meteorologists? Seems like a big challenge to educate prior to use.
- What will people or broadcasters use - high flow potential or inundation graphics?
    - Right now, anomalies are one month and three months.
    - Is there a running 3-month total?
- How many hours’ worth of QPF go into the NWM?
    - HRRR up to 18 hours, then GFS through 10 days.
- Multiple participants discussed the Hurricane Matthew example - mainly trying to understand the output and what is being displayed.
- Are the threshold values established?
    - Monthly averages.
- How was it created?
    - Tied to USGS streamflow statistics.
- How are the data processed (post-processing for local efforts)?
- Question on streamflow lengths, is has a length value but no units provided.
- What is normal? Need to see that as well.
    - Mention that RENCI is archiving the NWM output.
- Will NWM be able to go back and look at previous events, can this be used after the fact?
- Question about stage/discharge relationships. How can this be translated into inundation maps?
    - Some maps are being created by hand, using some assumptions and equations.
- What GPF is used in the NWM?

- HRRR in short range, GFS through medium range (10 days).

Feedback

- Now forecasters may have the ability to quantify quick changes that can then be communicated for the public, anomaly products for example.
- This interface may be overwhelming, forcing the user to spend more time filtering the information into useful parts.
- Low flow – tie in with national drought map percentiles.
- Would be helpful to provide the actual stream gauges and precipitation at that gauge.
- Using NWM throughout an event, long term vs near term (implied higher confidence).
- Archive ability request. Two reasons, looking at previous high water events and also to do a local event validation.
- Idea to compare big events, e.g. Floyd (99) vs Mathew (16) – how many more structures are in vulnerable locations now vs previous storms.
- Any internal bias-correction is not helpful and may be a negative impact on future events.
- Request to use HUC color scale
- Use this as a streamflow trace - being able to see upstream and downstream.
- Static URL for a given location, summary statistics.
- Cannot self-validate NWM output for a recent event as the model is quickly changing/evolving,
- Question about travel times or an animation to see "a drop" of precipitation fall upstream and how it flows down the watershed.
- Emergency manager mentioned 48 hour is critical threshold for EM services. North vs South of the Tar River, Contentnea Creek, deal with Flash Flooding when it occurs. Request to show how upstream dam releases flow downstream, visually showing the very minimal change in flood stage with additional streamflow releases upstream days after an event.

NOS Dashboard

- Can this be used for climate change impact scenarios, say run a given event adding SLR, perhaps increased rainfall, how will things look?
  - NOS are working on that at a coastal perspective. Would be interesting to see the river aspects as well.
- To what extent is this now being validated?
  - It is currently being validated for certain events. Version 1.1 is what is available now, version 1.2 is coming soon and will do better with sandy soil performance.

Uncertainty Products

- Deterministic vs ensemble outputs?
  - Need more computing power to be able to use NWM output ensemble in the short term.
- CSTAR project on HEFS use in NWM with the MARFC
- Interpretation comment: having QPF as a "layer" to see how modeled QPF is performing vs reality in the very short term. Also live radar estimates too.
- Hydrologic response has a lot of lag, are there ways to communicate streamflow or riverine system etc. changes using this model over different time scales, 1 hr vs 1 day vs 5 days.

Integrated Coastal Water Information Gaps

What information (products/services, both currently and in the future) do you need to inform critical decisions?

Longer lead times

- Need more than 48 hours of QPF going into prediction/hydrograph forecast (NWM will have 10 days). Ideally 3 or 4 days. Beyond that confidence decreases.
- Lead time of 48 hours minimum for any type of flooding event
- Water quality/drought: 30 days forecast too short. Risk running out of water.
    - Would need from 30 days to 9 -12 months (for water supply).
    - Inland: concerns are about reservoirs dropping below critical levels, intakes.
    - Need better understanding of base flow, antecedent conditions to prepare for higher than average baseline conditions.
- Surge perspective: do not have forecast until 48 hours ahead of time; ideally need 5 days (but more challenging to achieve).
    - Often 2-3 days needed for evacuation. If you wait for certainty, it is too late.

Gages and sensors

- Storm tide sensors: diverse coastline and amount of time takes to deploy makes placement challenging; need to make decisions 3-4 days in advance to try to determine where the greatest impact will occur. Then we can take subset of the likely most heavily impacted coastline to deploy sensors. Need information up front to guide these decisions. Highest density of impact.
- Storm surge 36-48 hours ahead of time is not enough – longer lead time needed on storm surge predictions, even range of minimum-maximum impact.
- More real-time sensors (rapid deployment): cannot release data from gages until *after* event. Also need suitable structures for deployment.

Knowledge of antecedent conditions

- Water quantity management: precipitation from previous storms created inundation that prevented flood plain function during Matthew. Knowledge of environmental conditions is needed prior to an event. Information on current state/levels, e.g. already above normal. (Maps of antecedent soil conditions?)
- Meetings after Floyd: inadequate drainage. Suggested opening up constrained drainage areas. Regulating development to prevent further impacts was also discussed.
    - Land use management issues – stormwater management needs to be improved.
- Coastal topography needs to be kept up to date.
- Need Information and understanding of groundwater and drainage systems before an event.

Inundation products:

- Better inundation mapping for freshwater flooding is necessary to inform services during and after event.
    - DOT website should be accurate source of information on road conditions (currently is not).

    - Social media is filling gap but there should be forecast products that are accessible, even if only 12 hours in advance.
    - Need inundation map that is updated at least daily.
    - Mapping also needed along river basin and into creeks.
    - Google maps can be used.
- Temporal and spatial changes need to capture coastal coupling: Surge event will die down but then inland peak flooding waves occur – can be days until water pushes down river.
- Wind, tides in Sound were driving the water and creating drainage issue; there was a mounding effect from Sound. Is this/can this be incorporated into the inundation product?
    - Needed throughout duration of event
    - NWS needs validation on how to incorporate all information into one place.
    - Being able to display water movement is important; need inundation map that covers the entire area. Start with real time and go forward (predict and observe water levels).
        - Need reference point on map to guide deployment, e.g. water level, landmarks.
- Public wants to see their community on a map – need to zoom in on inundation map. Keeping maps up to date (groundtruthed via satellite, etc.) is important. Include worst/best/most likely case scenario – range integrated with inundation maps.
    - Also for tourists, people who do not know the area: need to know how to communicate with them.
- Responding to inundation: decisions need to be made about agricultural operations – which lagoons at risk, when to irrigate. Which may need more staff deployed.

Communication/education

- Education component needed to convey spatial issues – e.g. hurricane center cone. People think if you are in the cone, you will be impacted.
    - Cone products should be communicated separately.
    - Conveying all factors in one cone graphic is challenging
    - Public needs to hear same message from all sources.
    - Way we categorize hurricanes – different storms impact differently depending on approach direction
    - Flood peak may come 10 days after rain – public thinks when the storm is over, the water will recede.
- How will any products visible on mobile device? This is critically important especially for younger generations.
- Need to combine tidal information with rainfall forecast. NWS exploring how to show this. Impacts right now are total guesswork – no way to visualize projected impacts currently.
- Managing public's expectations is a challenge
- High water signs are effective – e.g. student housing – put out sign, visual display to show high water mark.
- Communicating severity of flooding, other threats. Public becomes desensitized to messaging. Need to tailor messages to particular groups especially those most at risk.
- Being able to find data is a challenge. EM interface for all products/services/data.
    - Hurricane track, riverine flooding, etc. to support emergency response decisions.
    - Hurricane – site should have all data relevant to impacts.
    - People want to know impacts – translate minor, moderate, major flooding to impacts.

- Road closing information accuracy, accessible on smart phone is critical, can show via Google maps – where to go, not just where to avoid.
- A more interactive decision support tool is needed to inform decisions at the local level.
    - For planning purposes (to mitigate impacts). E.g., local inundation hotspots and limiting development.
    - Needed for both flooding and drought

Uncertainty and Other

- Dam failure is difficult to track. NWS issues alerts on dams.
- Total water levels along intercoastal areas, tidal river gage areas. How to forecast this?
    - 48 hours – Need 3 to 5 days.
    - AHPS. Use this to push it out to local users.
    - Minimum 50 foot resolution needed
- Merging meteorological and hydrological drought. Probabilistic product to communicate drought (Drought Monitor does not look ahead).
- Need to be able to communicate the uncertainty associated with a 5 day forecast during briefings. Give scenarios (tropical storms, ex-trop storms). Even low certainty forecast is better than nothing.
- Probabilistic QPF; ensemble approach.

Large Group Debrief

Voting – Top Needs	**Partners**	**NOAA staff**
Longer lead times on water predictions (A)	9	3
Real time water sensors (B)	9	4
Real time and forecasted inundation maps (total water level - surge, riverine, winds, tides, etc.) at the street level and available on smart phone (C)	18	9
Antecedent conditions in water predictions (e.g., soil moisture, water table) (D)	5	1
Keeping topography information up to date (E)	1	0
Developing cone of impact/ all-hazards impact cone (F)	3	2

Lunch Discussion

- What is the specific flood inundation time looking at?
    - 48 hours window, deploying sensors 4 or 5 days in advance.
- Tradeoff between lead time and uncertainty.
- If you provided more lead time with probabilistic data that would be sufficient?
    - EMs want longer lead time because residents won't leave.
    - EMs need to make predictions for evacuation. Ocracoke – 5 days is needed because evacuating people by ferry.
- Surge gets people to evacuate, not wind.
- Storm surge accurate forecast: out to 12 hours.

- Four days out NWS will start running PSURGE. Really a stretch to get out to 72 hours. MEOWs and MOMs.
    - Yes, 5 days possible, but very uncertain.
- *Real time and forecasted inundation maps (total water level - surge, riverine, winds, tides, etc.) at the street level and available on smart phone (C)*: which components of this are most important?
    - Forecast is most important, 5-7 days. And street level so we know which students to evacuate.
    - But static maps are still useful.
    - Knowing what routes can be travelled, which roads passible in the next 6 hours which critical infrastructure will be inundated, hog lagoons, etc. Next 6 – 12 hours.
        - Overlaying forecast on geospatial intelligence.
        - Also maybe include what got flooded the previous event.
        - Google maps re-routing.
    - Forecast is most important because helps you plan your management.
    - Integration of tides and rainfall – integration – so we don't have to look at 4 or 5 different products (particularly at the coast).
- *Developing cone of impact/ all-hazards impact cone (F):* Way to convey (beyond the track) impacts.
    - If using photo simulation of 29 feet in your town with city hall under 29 feet.
    - UNC King Tides product – inundation dashboard.
- How to get to the untrusting members of the public:
    - Weather ready nation ambassador program
    - Makes a difference to see NWS staff in their community
- "Anomaly" the right term to use?
    - "Departure from normal" instead.
    - Translating NWM into actual risk is a good step in right direction.
    - What is a meaningful anomaly? High, medium, low – what does it mean to applications? Need to define intervals.
        - Would be difficult to use it/apply it because so much data. Maybe just on major rivers.
        - Almost too much detail.
    - Longer lead time – one hour is fine for flash flood, but longer for other events.
    - Have to put flow in context.
    - "New high for the day" some people like it tied to the USGS color ramp, some don't.
    - Assumption that flows will not translate into impacts in basins – start to translate.
    - NWC no way to produce the impacts, but local offices will need trainings/guidance to go there.
- Would help to have depth as well.
    - Yes, on NWC radar to generate those types of maps.

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