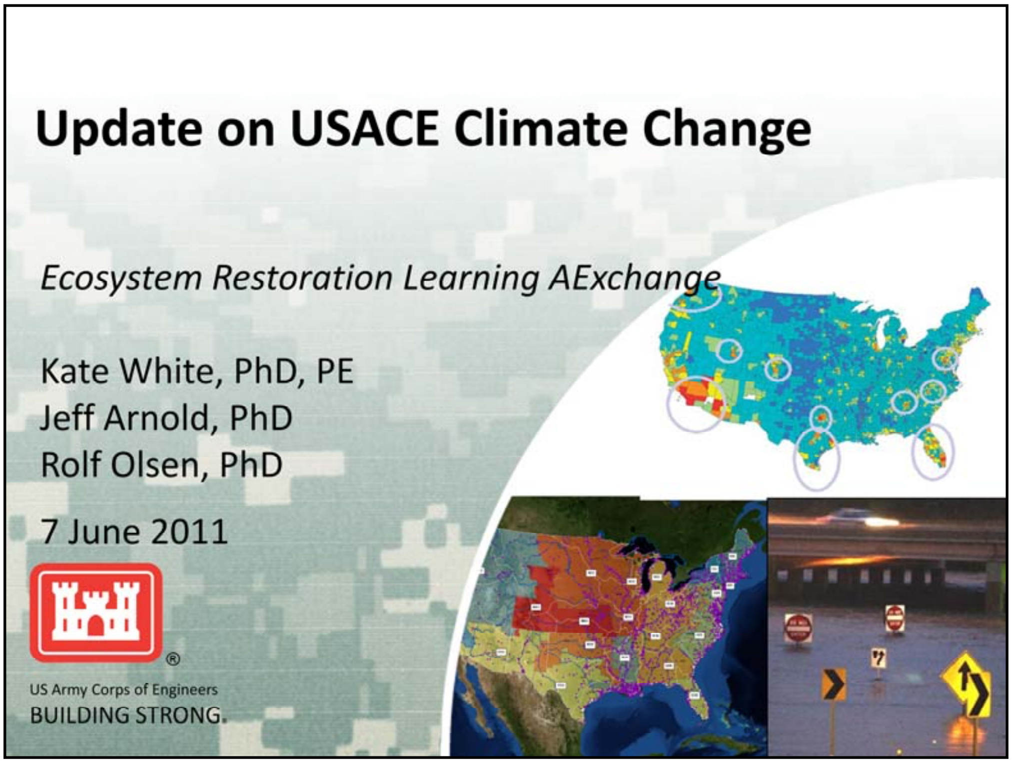


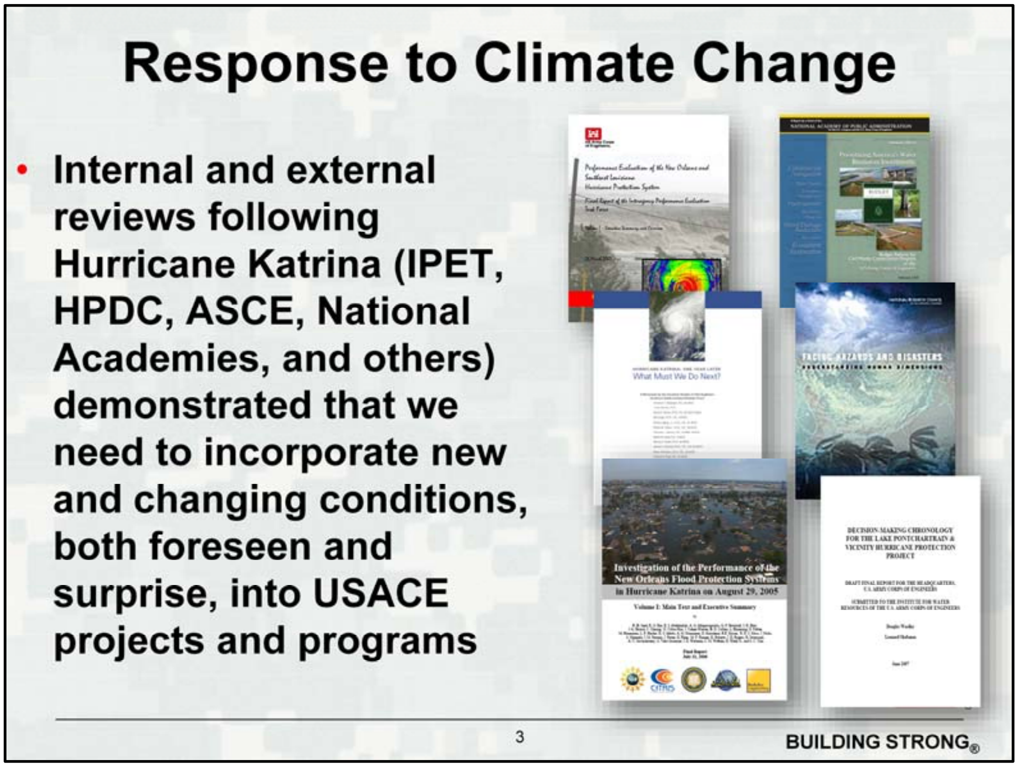
This brief presents information on climate change adaptation and why it is important to integrate adaptation and mitigation efforts.

USACE teams participated on the working groups under the Interagency Task Force on Climate Change and also helped develop the Implementing Instruction for Federal Agency Adaptation to Climate Change, issued on 4 March 2011 in accordance with EO 13514. IN this way, we had a unique opportunity to help shape the guidance to fit the needs of land and water resources management agencies like the USACE

The Implementing Instructions and the Companion Support Document can be found at http://www.whitehouse.gov/administration/eop/ceq/initiatives/adaptation

Outline

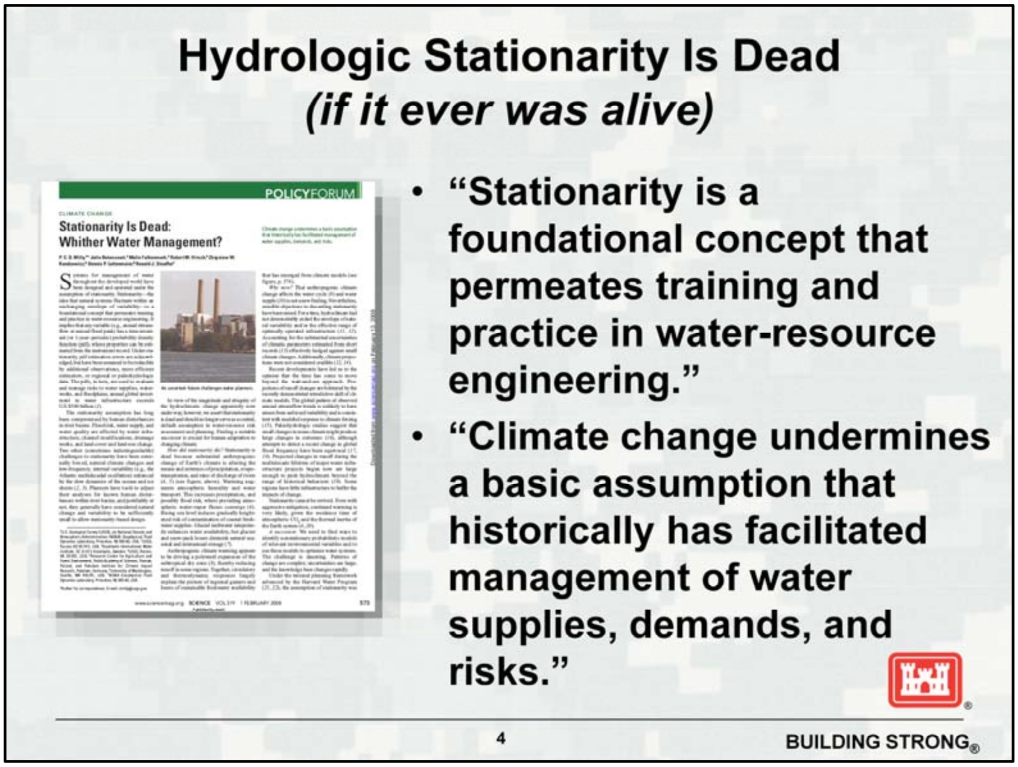
- Why Adaptation?
  - Katrina
  - Nonstationarity
  - Climate change commitment
- Adaptation in the context of USACE CW
  - Programs and progress
    - USGS Circular 1331
    - Example guidance: sea-level change
    - Adaptation challenges
    - Complex systems
  - Adaptation pilot projects
- Next webinar



Our impetus to prepare for climate change came from internal and external reviews following Hurricane Katrina.

These reviews were provided by the Interagency Performance Evaluation Team (IPET, see https://ipet.wes.army.mil/), the Hurricane Protection Decision Chronology (HPDC, see http://www.iwr.usace.army.mil/docs/hpdc/hpdc.cfm), the American Society of Civil Engineers (ASCE, see http://www.asce.org/uploadedFiles/Publications/ASCE_News/2009/04_April/ERPreport.pdf) and the National Academies (see http://www.nae.edu/Publications/Bridge/EngineeringfortheThreatofNaturalDisasters/LessonsfromHurricaneKatrina.aspx), among others.

The results of these were a clear indication to us that we need to incorporate foreseen and surprise changes into our projects and programs. The IPET-HPDC Lessons Learned Implementation Team began working in 2006 to develop guidelines and recommend policy and program changes along with supporting technologies, to address dynamic processes, temporal and spatial changes, and their impacts to USACE projects on watershed, regional or system scale (e.g., subsidence, climate change and variability, sea level change).



The need to consider new and changing information highlighted by Hurricane Katrina emphasized the need for USACE to really understand and act on the knowledge that the world is dynamic.

This is important, because during the early- to mid-20th century era of Federal infrastructure building, engineers designed water resources projects using what would now be considered relatively simple tools on the basis of short observed hydrology records.

Lacking sophisticated dynamic process models and computational techniques, two primary factors enabled them to design and construct the many projects still in operation today:
1) inherent conservatism in design and
2) the assumption of stationary hydrology (i.e., that hydrology varies within an unchanging envelope of natural variability, so that the past accurately represents the future).

Conservatism in design (e.g., factors of safety) has been replaced in many cases by risk-based design. While alleviating issues associated with the economic cost of conservatism, risk-based design is highly dependent on projections of future conditions and the inherent uncertainty of the system.

The assumption of stationary hydrology allowed water resources managers to transform complex and uncertain hydrology into a form tractable for planning, engineering, and management of water resources projects given the resources available at the time.

Today, there is growing recognition that, despite its successful application in the past, the assumption of stationarity may no longer be valid. However, before this assumption can be overturned, Federal agencies require an alternate approach that provides consistent, repeatable analytical results supporting resilient infrastructure design.

We don't yet have these methods, with the result that hydrological nonstationarity can induce additional risk and uncertainty in project planning, design, construction, and operations.

Addressing user needs:
 Nonstationarity workshop: *Nonstationarity, Hydrologic Frequency Analysis, and Water Management* (Jan 2010)
 Provide peer-reviewed basis for consistent policies
 Science agency responses to user needs docs (2010-2011)

Climate change impacts to inland hydrology presents more uncertainty than coastal impacts, and thus the pace is a bit slower.

Here, USACE and Reclamation (representing operating agencies) and NOAA and USGS (representing science agencies) formed the Climate Change and Water Working Group (CCAWWG) to identify and fill knowledge gaps related to water resources management challenges due to climate change and variability.

Their first effort culminated in the publication of a joint report (USGS Circular 1331, Climate Change and Water Resources Management: A Federal Perspective) in February 2009. This report contained a preliminary listing of user needs (i.e., climate information and service needs of federal, state, and local water resources agencies).

The user needs associated with longer term water resources time horizons have been captured in a draft report by USACE and Reclamation in review: "Addressing Climate Change in Long-Term Water Resources Planning and Management: User Needs for Improving Tools and Information."
USACE and Reclamation are currently preparing CCAWWG draft report documenting user needs associated with shorter term water resources time horizons: "Use of Weather and Climate Forecasts in Federal Water Resources Management: Current Capabilities, Required Capabilities, and Gaps."

In January 2010, USACE hosted (on behalf of CCAWWG), a workshop for national and international experts on "Nonstationarity, Hydrologic Frequency Analysis, and Water Management" in Boulder, CO during January 2010.

Discussions during the workshop addressed whether assumptions of stationarity are valid, use of different statistical models in nonstationarity conditions, trend analyses, how to use the output from global climate models (GCM), and how to treat uncertainty in planning, design, and operations. The workshop proceedings were released in June 2010. A special issue of the Journal of the American Water Resources Association is in preparation.

Good Practice Guidelines for Approaches to Produce and Use Climate Change Information for Adaptation of Water-resource Infrastructure

Decisions about climate change adaptation measures to enhance the resilience of the infrastructure, planning, and operation of water-related resources in the US require reliable information about the variability and uncertainty of probable climate change effects at the spatiotemporal scales where the decisions are taken. A large portfolio of possible approaches to produce and apply climate change information for water resource issues has been developed, and many of those approaches are in use now. Each method or analytical technique in this portfolio brings a set of uncertainties and particular deficiencies, some of which are large or only partly characterized and poorly quantified. For example, the spatiotemporal scales natively available from most climate model projections may be too coarse to be usefully mapped to the scales of some of these adaptation decisions. Moreover, guidance to determine the appropriate level of complexity in the analysis of climate information for a decision and its likely consequences is currently lacking. For these reasons, Federal agencies charged with water resource planning and operating missions must address whether and how to develop guidelines and principles for producing climate change information they will use to support their variously scaled decisions on adaptation measures.

This workshop will help characterize the strengths, limitations, variability, and uncertainties of approaches for using climate change information to inform water resources adaptation planning and operations.

The issues, questions, and problems involved here are diverse and include:

1- The choice of native-resolution climate data, which models and which scenarios;

2- The spatiotemporal downscaling methods with their limits and uncertainties;

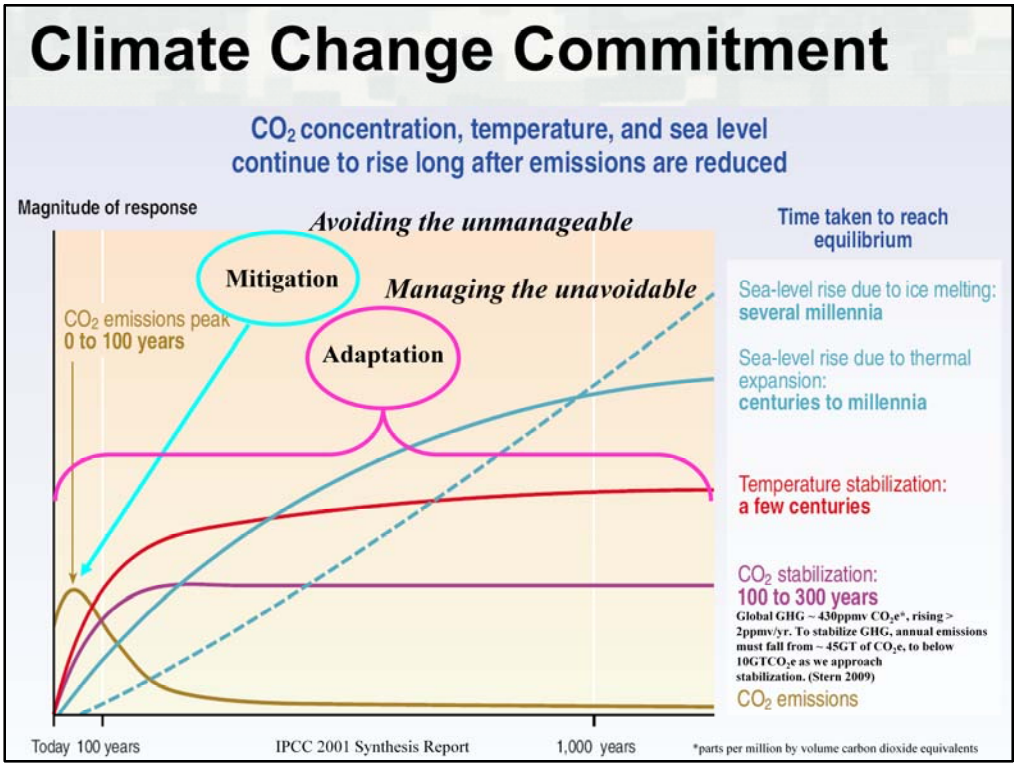
3- The temporal, social, and legal constraints on the various water-related planning and operating missions of diverse Federal agencies.

The chief products of the workshop will be:

1- A more comprehensive description of the sensitivity of the portrayal of these complex systems and related decisions to the early-stage choices of approaches and techniques;

2- Better knowledge for delineating a consistent means to develop the decision-scale climate information needed for adaptation across the portfolio of approaches and techniques; and

3- Principles and guidelines for assessing approaches in the portfolio, together with the range and influence of their variability and uncertainty, for their utility and reliability to support water resource adaptation.



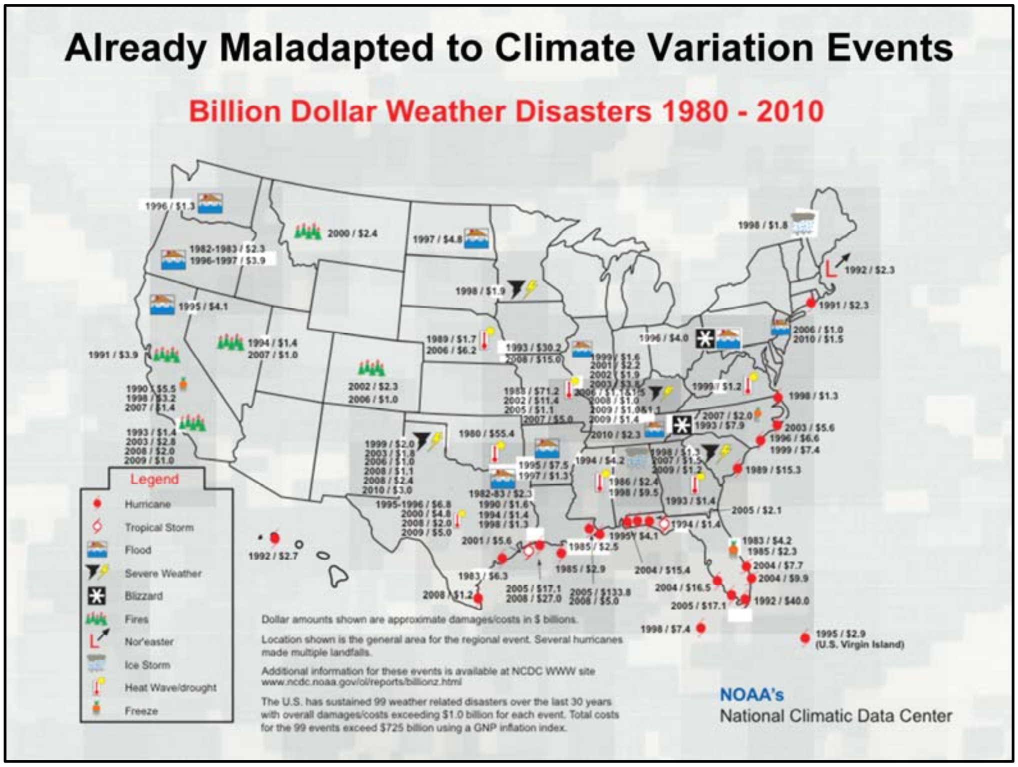
And there's another reason we need to consider climate change: the climate change commitment. We know that atmospheric CO2, global average air temperature, and global sea level will all still rise long after greenhouse gas emissions mitigation begins. Thus, we are already committed to a certain amount of climate change.

This climate change commitment:

- Requires both mitigation (***Avoiding the unmanageable***) and adaptation (***Managing the unavoidable***)
- Necessitates long-term as well as short-term planning
- Compels urgent action

Intergovernmental Panel on Climate Change (2001): Climate Change 2001: Synthesis Report; contribution of Working Groups I, II, and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change, (ed.) R.T. Watson and the Core Writing Team, Cambridge University Press, 398 p.;

Stern, N (2009) Key Elements of a Global Deal on Climate Change. London: London School of Economics.
http://www.occ.gov.uk/activities/stern_papers/Key%20Elements%20of%20a%20Global%20Deal%20-Final01may.pdf

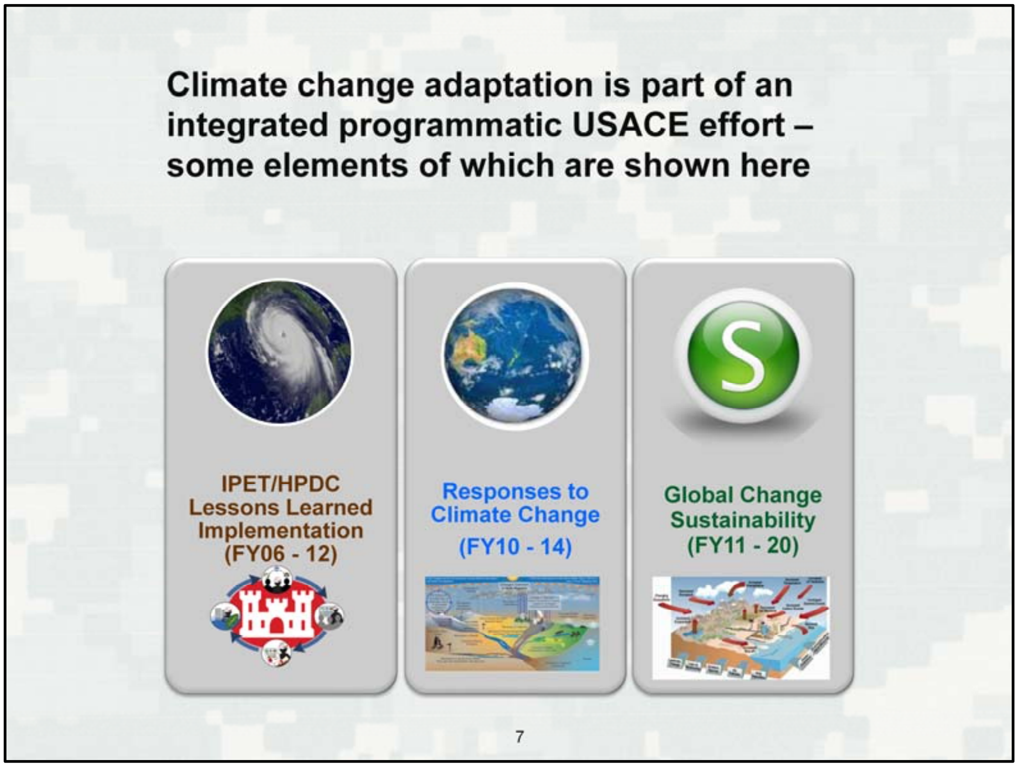


How is adaptation different from mitigation?

Climate change adaptation is inherently different in many ways from mitigation/conservation.

For example:

- Adaptation problems are more complex and interconnected in ways that we do not yet understand
- They will require totally different skill sets and knowledge
- The methods and approaches not well understood
- Cause and effect may be far apart in time and space, complicating analyses
- The results are not easily quantified with current knowledge
- Science translation is a critical and important ongoing process
- Monitoring and adjustment will be necessary for many adaptation actions
- Implementation scale (time, cost, realization of outcomes) is very different
- Emphasis on short-term, accounting-type approach comes at cost to long-term social, environmental, and economic equity, which is a cornerstone of effective adaptation



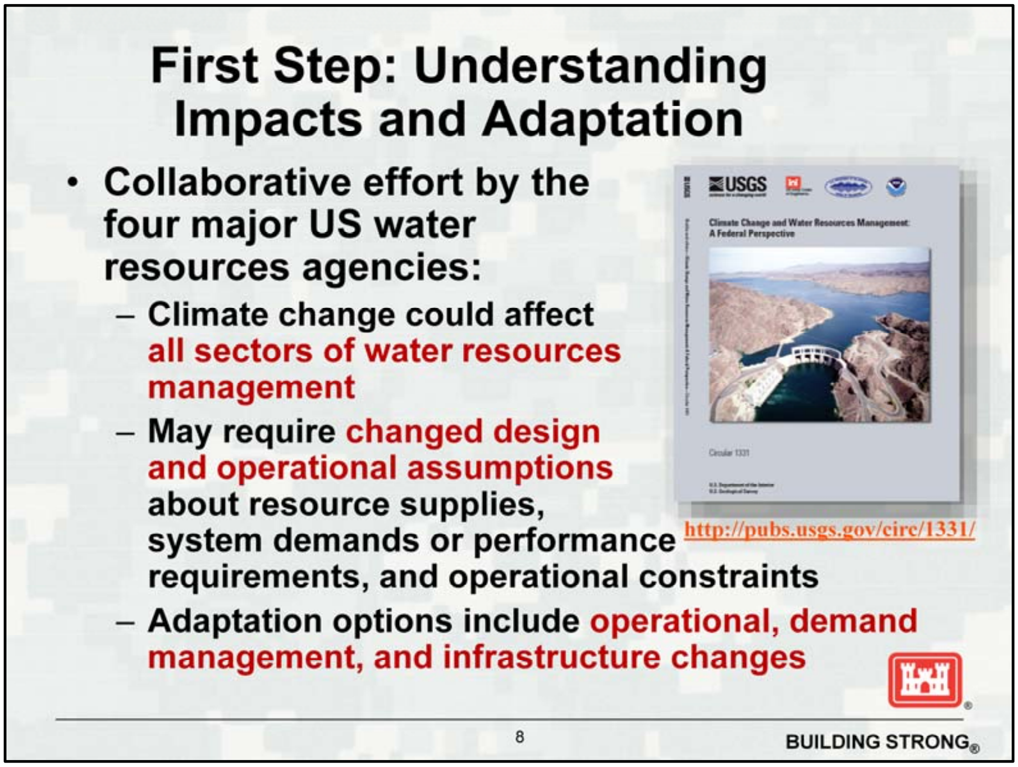
The USACE began dealing with climate change adaptation issues as a result of internal and external analyses following Hurricane Katrina, through the IPET-HPDC Lessons-Learned Implementation Team. This program supported activities like USGS Circular 1331, our sea-level change guidance, and explorations of nonstationarity. The program also began addressing climate change mitigation in the context of Big S sustainability beginning in 2007.

InFY10, the Responses to Climate Change Program began. This program is supporting climate change adaptation pilots, vulnerability assessments, and updates to policy and guidance. **See http://www.corpsclimate.us for more information.**

The FY11-20 Global Change Sustainability Program enhances the sustainability and resilience of our built infrastructure and the natural environment by providing a proactive, nationally consistent, and regionally sensitive framework and program of actions that will reduce the impacts and costs of dynamic global changes such as changes in demographics, land use and land cover, socioeconomic and political conditions, and subsidence, as well as climate change. This builds on the lessons learned from both programs, and begin implementing the actions identified by them.

Some activities of the GCS program are:

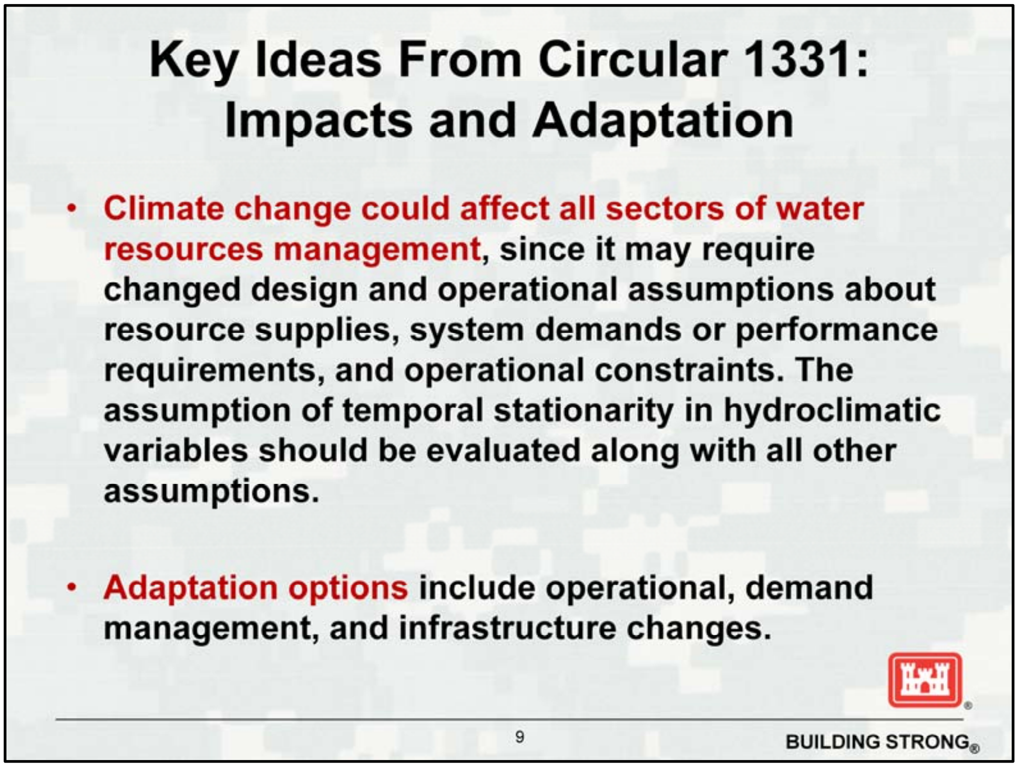
- Update drought contingency plans at USACE reservoirs to take into account current future projections according to strategic and priority needs.
- Conduct a comprehensive review USACE projects with respect to sea-level change in all phases of their life cycles.
- Develop policies and methods supporting consistent management strategies for dealing with global changes in coastal zones.
- Update reservoir sedimentation studies according to strategic and priority needs.
- Analyze the vulnerability of ecosystems and ecosystem processes, ecosystem services, habitats, and biological diversity to global change effects and develop strategies and methods to increase resilience and sustainability.
- Develop and initiate a strategy and policy to foster efficient and informative sharing inside USACE and to other agencies of the technical information needed to effectively address resiliency of the built infrastructure and the sustainability of the natural environment.



Climate change and its potential impacts on water resources have become an increasingly common topic at meetings among water managers. This is particularly true for the four Federal agencies that have collaboratively managed data and information for water resources since their founding. Faced with obvious climate effects to water resources management due to changes in temperature and precipitation, we began a collaborative effort in 2007 called the "Climate Change and Water Working Group."

"The four agencies, two termed "operating agencies" (USACE and Reclamation) and two termed "science agencies" (USGS and NOAA), share a symbiotic relationship, where the operating capabilities required by one agency may drive the direction of science inquiries for another, which in turn may result in improved knowledge and processes for operations. Similarly, the data collected and compiled by one agency for a specific purpose can be used by another agency to supplement other data and information for an entirely different purpose." (from USGS Circular 1331)

The first task of this group was to develop a comprehensive assessment of climate impacts to water resources, including potential adaptation measures. The interagency team began in May 2007, and their work culminated in USGS Circular 1331, published in February 2009.



In the executive summary of USGS Circular 1331, the agencies noted that climate change could affect all sectors of water resources management, both coastal and inland, and laid out adaptation options.

They also identified knowledge and technology gaps, and began laying out a collaborative strategy to fill these gaps, beginning with the most high priority needs.

In 2010, CCAWWG sponsored two workshops with national and international experts on critical issues posed by climate change adaptation:

1- how to deal with hydrologic nonstationarity in analyses of water resources projects, and

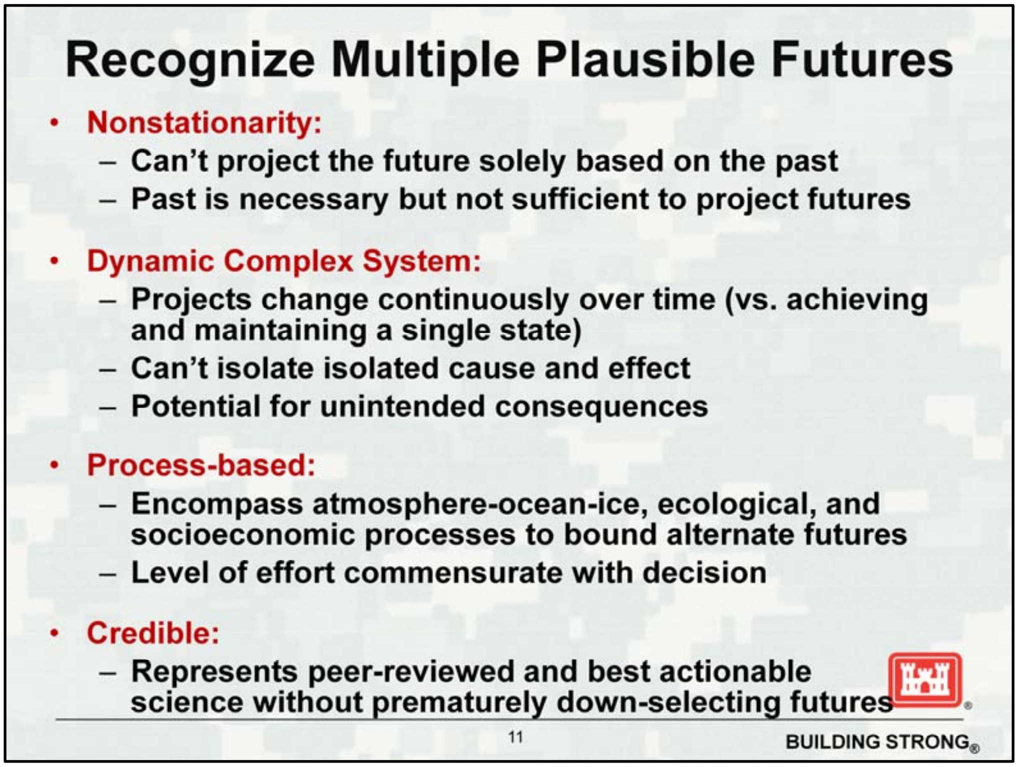
2- good practice guidelines for producing and using climate change information to make adaptation decisions.

The results of these workshops will support the development of USACE engineering policy and guidance for adaptation planning.

In 2011, USACE and Reclamation published the results of a more detailed investigation of water resources operating agency needs with respect to climate change adaptation, including the perspectives of their agencies and partners. The report "Addressing Climate Change in Long-Term Water Resources Planning and Management: User Needs for Improving Tools and Information” will be followed by a companion report prepared by the science agencies USGS and NOAA that presents a strategy to meet these needs.

Adaptation Challenges

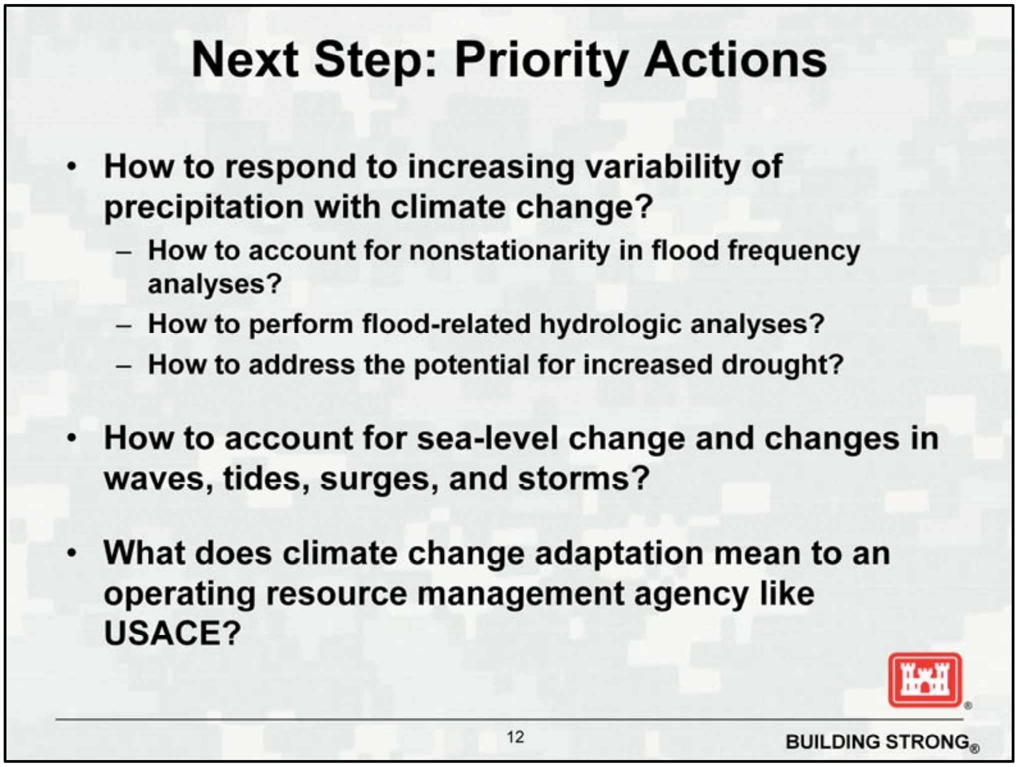
- A **clear roadmap** is required for field implementation of this ill-structured problem involving complex systems with longer planning and adaptation horizons
- Framework must account for **nonstationarity**
- Nonstationarity means there are **multiple plausible without-project future conditions**
- We must define **levels of analysis** commensurate with the decision scales in terms of time, funds, technical resources, consequences, and other factors
- Need to incorporate **adaptive management and anticipatory engineering** into the USACE business process – without an "open checkbook"



As we conduct our evaluations and formulate management plans, we must be careful that we do not prematurely down-select to one future, in a way that reduces our ability to explore potential future conditions to manage risks, and especially when this increases residual risk.

So we need to be aware that the future is nonstationary, that we need to describe the future in ways that are compatible with our need for economic and engineering analyses, and that encompass all of the processes affecting our projects and systems, including socio-economic and environmental.

Finally, our future must be credible, relying on best available ACTIONABLE science, and legally justifiable, as well as logical and rational.



USGS Circular 1331 found that there would be short- and long-term climate impacts to all areas of our water resources management mission.

We already knew from our internal program set up to deal with changes in response to Hurricane Katrina (the IPET-HPDC Lessons Learned Implementation Team) that we must have methods, technologies, processes, and policies to incorporate the effects of new and changing conditions into our projects and programs, over the entire lifecycle, using a risk-informed, comprehensive systems approach.

Our immediate concerns were with those areas of our mission that have a life-safety component, such as floods and coastal storms. We’re also very concerned about drought issues, since the impact several of our mission areas. Here are some of the priority questions we faced.

Adaptation Approach

- **Actionable:** build on best actionable science developed by the science agencies, academia, private sector, and other experts
- **Diverse:** involve multi-disciplinary, vertically and horizontally integrated team, exploit diverse perspectives
- **Parallel:** focus effort by subareas to develop in parallel rather than sequentially
- **Refine:** learn through pilots, demonstrations, and peer review to refine and update knowledge and guidance

13 BUILDING STRONG®

In response to the water-related risks posed by climate change, the Corps has embarked on a comprehensive approach to climate change that is flexible enough to incorporate new knowledge and changing conditions.

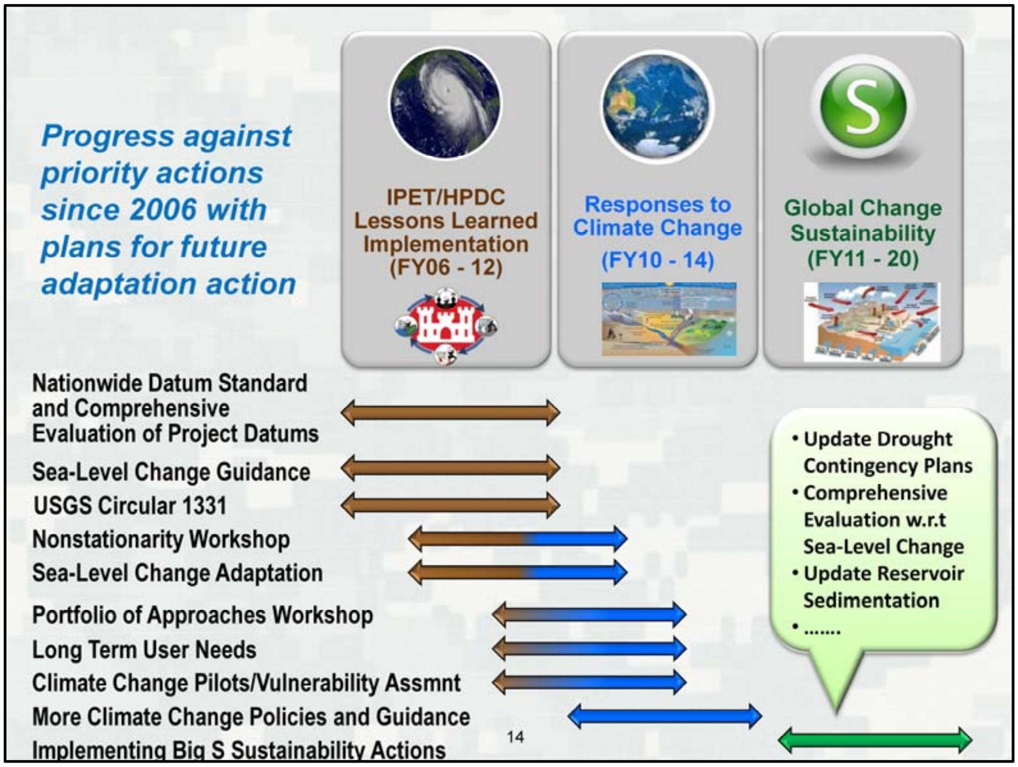
Our goal is to develop practical, nationally consistent, legally justifiable, and cost effective measures, both structural and nonstructural, to reduce vulnerabilities and improve the resilience of our water resources infrastructure.

We are taking a collaborative approach. This has required a new attitude to partnering between agencies that recognizes the value of our different perspectives and expertise so that guidance reflects the best available ACTIONABLE science, and in turn, the science is guided to support our needs.

We are developing and implementing plans, policies, and infrastructure adaptation in parallel, rather than sequentially, so that adaptation begins soon for projects that are most vulnerable.

We are taking a phased approach that allows us to identify uncertainties, whether in climate projections or in systems responses, so that we begin adaptation in areas where uncertainties are relatively smaller. Thus, risk of adverse consequences is lower.

We are pilot-testing adaptation methods, sharing lessons learned within and outside the Corps, and refining our adaptation based on the new knowledge.



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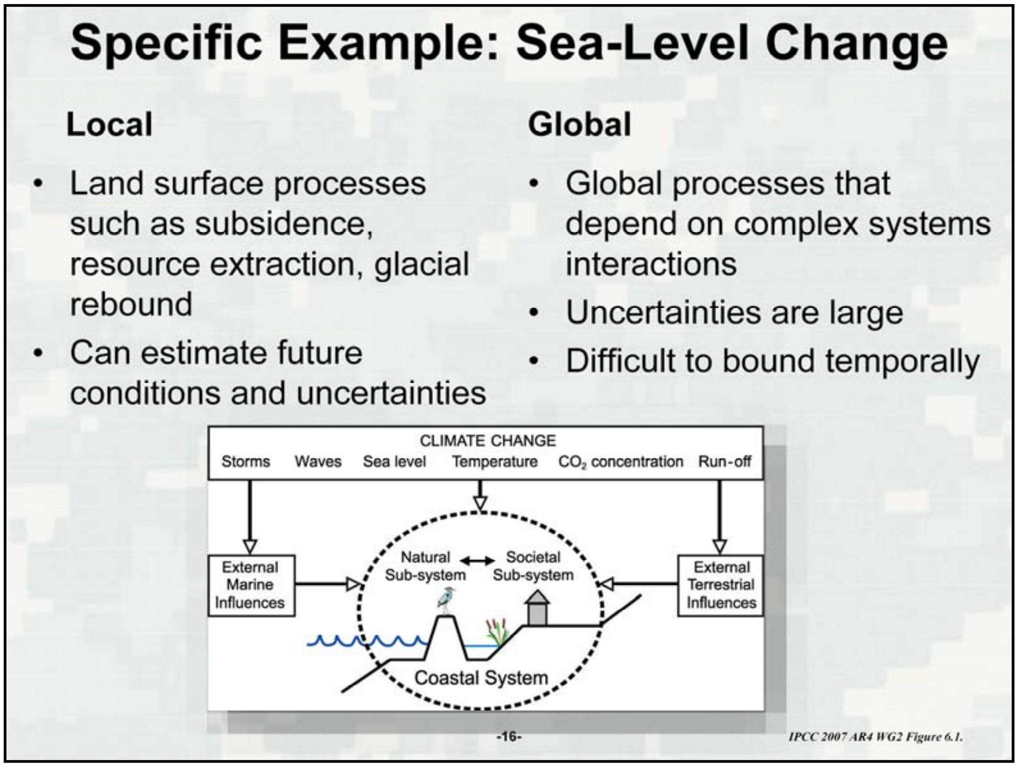
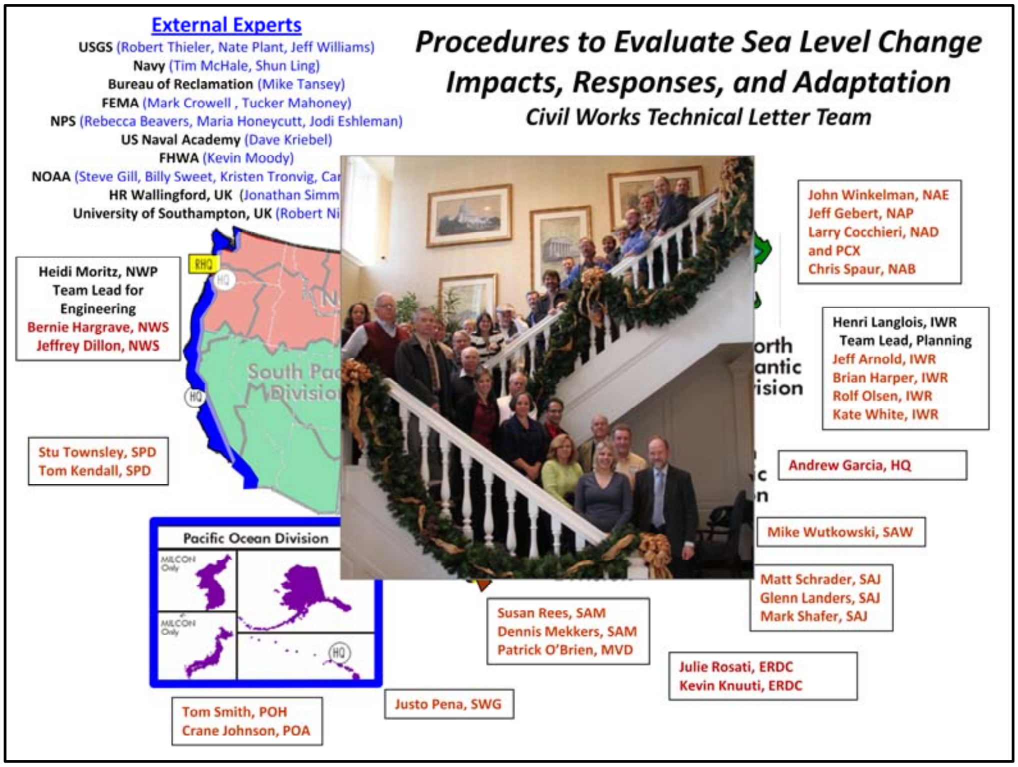
- Develop policies and methods supporting consistent management strategies for dealing with global changes in coastal zones.
- Update reservoir sedimentation studies according to strategic and priority needs.
- Analyze the vulnerability of ecosystems and ecosystem processes, ecosystem services, habitats, and biological diversity to global change effects and develop strategies and methods to increase resilience and sustainability.
- Develop and initiate a strategy and policy to foster efficient and informative sharing inside USACE and to other agencies of the technical information needed to effectively address resiliency of the built infrastructure and the sustainability of the natural environment.



This figure from the IPCC shows the complex inter-related system around coastal climate change, with the major climate change factors, including external marine and terrestrial influences.

But also, this figure shows the very uncertain interaction between the socio-economic and natural system components – and these are difficult enough to project into the future without the added potential effects of climate change.

And it is exactly the range of future conditions that we must understand in order to prepare and adapt our coastal communities. The USACE has a large coastal program that supports inland and maritime transportation, hurricane and coastal risk reduction, and ecosystem restoration. Our existing coastal infrastructure includes both natural and constructed components. So, we’re very interested in what the future holds for coastal areas.



Here's another example of collaboration with other agencies in climate change adaptation planning: sea-level change.

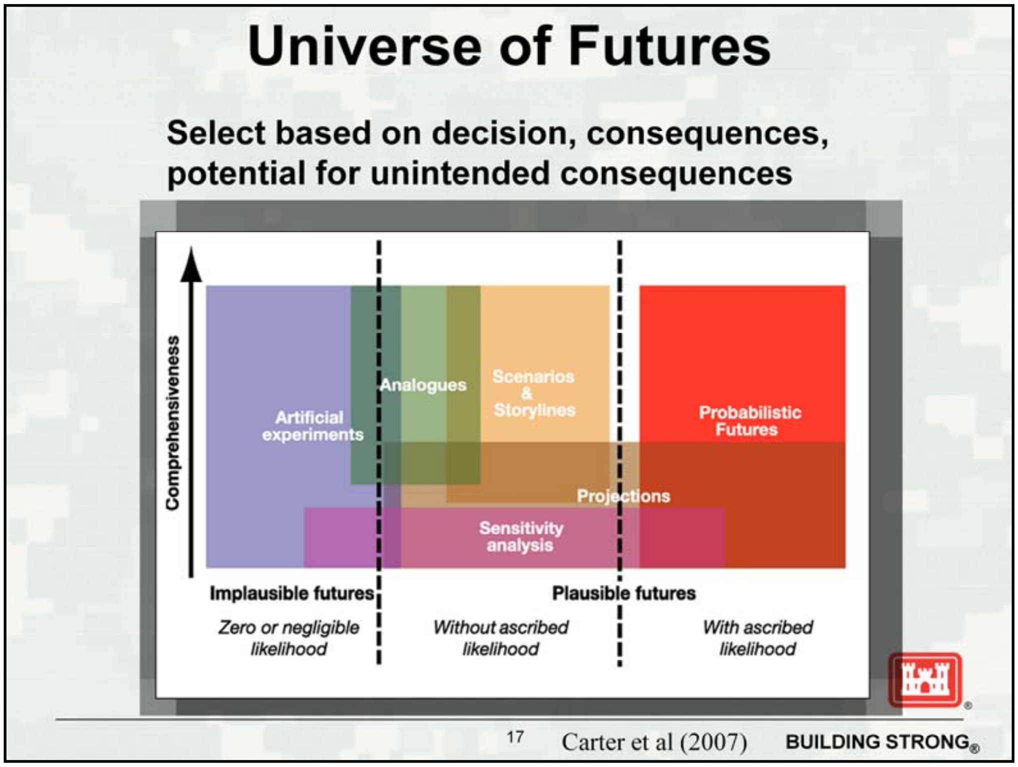
The USACE has long recognized the potential of changing sea levels to impact our projects. We put out our first guidance on the subject in 1986 - even before the publication of the influential 1987 National Research Council study "Responding to Changes in Sea Level: Engineering Implications."

Our most recent update was in 2009. We developed that guidance with help from top sea-level science experts at NOAA's National Ocean Service and the USGS. We also considered the approaches being taken by our stakeholders.

We are now working on guidance for adaptation to sea level. We are leading the way in collaboration both within USACE through the use of virtual teams at all levels of the organization, and through inclusion of the best national and international experts we can find.

We want to make sure our work is consistent with other Federal agencies, so we've invited agencies such as NOAA, USGS, Navy, Federal Highway Administration, FEMA, and Reclamation to take part in our guidance update teams. This allows rapid knowledge transfer between agencies and gives them a jump-start as they develop their own guidance.

We also work with state and local collaborators to help mainstream the new information.



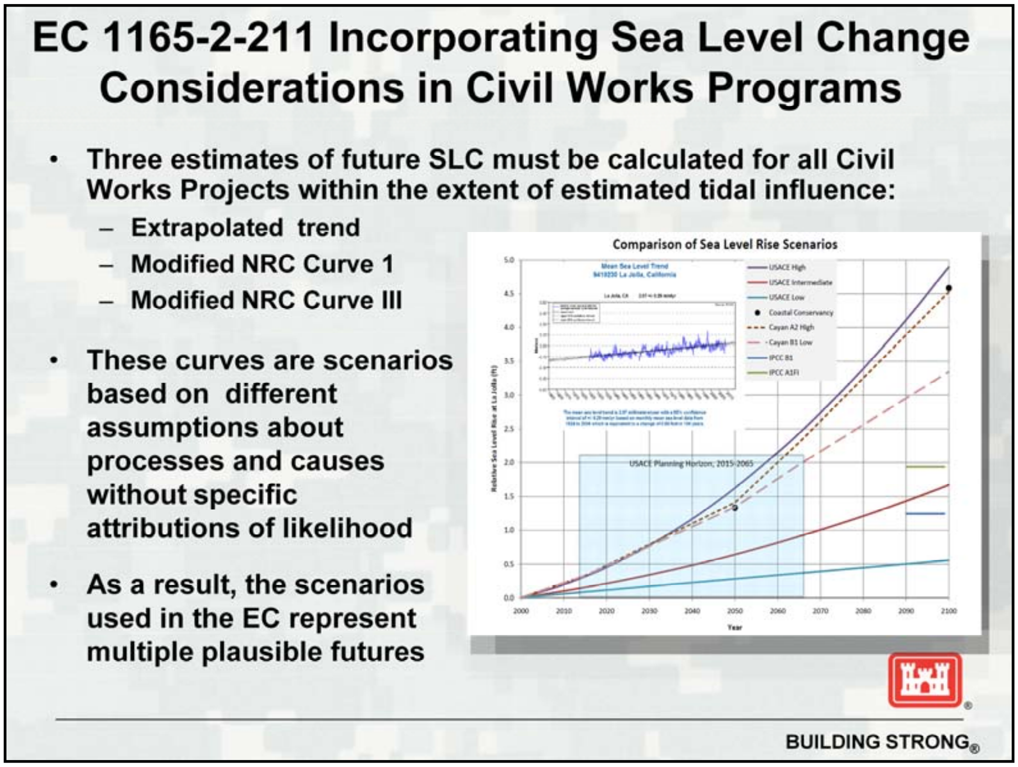
There is a whole universe of futures – our challenge is to select one or more methods that are appropriate for the decisions to be made, based on the potential consequences, the potential for long-term unintended consequences, and of course, our other decision-making processes.

As we conduct our evaluations and formulate management plans, we must be careful that we do not prematurely down-select to one future, in a way that reduces our ability to explore potential future conditions to manage risks.

There is a strong preference for describing futures using probabilities. But at the same time, the desire for probabilities may lead us to a sense of false precision. Because of this tendency, we need to look a little deeper and try to scale our level of understanding to the scale of the decisions we are making. And as Grubler and Nakicenovic suggested over 10 years ago, "**We need to research all the potential outcomes, not try to guess which is likeliest to occur**."

In general, scenarios are appropriate when uncertainties are large, the consequences are significant, and outcomes cannot be bounded.

Sea level change (and more broadly, broader climate change) meets the first and last of these three conditions. For the second condition, we use sensitivity testing to determine the potential consequence of sea-level change. That sensitivity test guides our scope of study and the rigor of the scenario analysis.



So, how do we apply these approaches?

The lowest blue curve is the extrapolated historical trend, which is an extrapolation of the data shown in the inset box. This curve is primarily controlled by regional sea level change projection and land uplift or subsidence.

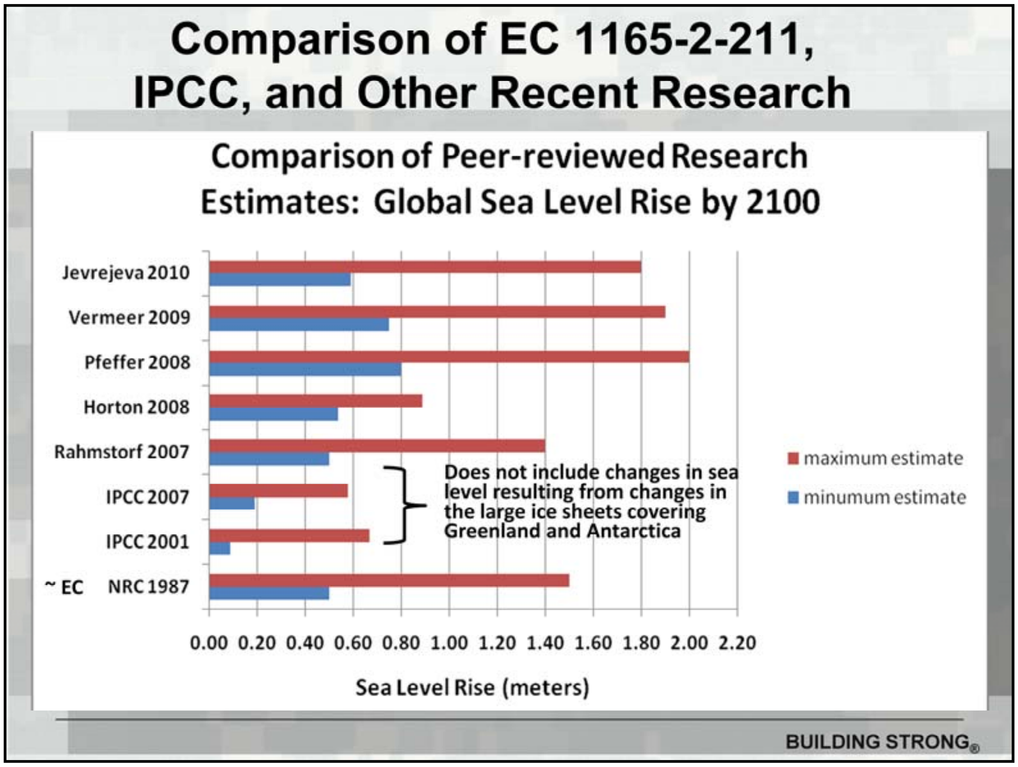
The red intermediate curve is the updated 1987 National Research Council (NRC) curve 1. The blue and green markers that bound this line indicate the 2007 IPCC SRES low and high estimates (SRES = special report on emissions scenarios, a subset of 6 of the IPCC projections). The IPCC in 2007 does not provide an analytical expression of sea-level change that allows us to develop a curve, but rather a single point in time in the future. The purple line provides the updated NRC curve 3.

We can also represent stakeholder scenarios or projections. For this location, the dotted lines on the graph show locally-generated estimates from Scripps Institution of Oceanography (Cayan). And the black dots denote Coastal Conservancy estimates.

The blue shaded box indicates the Corps' typical planning horizon.

NOTE: According to the IPCC 2007 Synthesis for Policy Makers: "Because understanding of some important effects driving sea level rise is too limited, this report does not assess the likelihood, nor provide a best estimate or an upper bound for sea level rise. Table SPM.1 shows model-based projections of global average sea level rise for 2090-2099.[10] The projections do not include uncertainties in climate-carbon cycle feedbacks nor the full effects of changes in ice sheet flow, therefore the upper values of the ranges are not to be considered upper bounds for sea level rise. They include a contribution from increased Greenland and Antarctic ice flow at the rates observed for 1993-2003, but this could increase or decrease in the future.[11] {3.2.1}"

So IPCC did not assign likelihoods, nor did it intend to establish an upper bound for the projected 2099 levels.



How does our guidance compare with recent estimates?

Again, as noted previously, "Because understanding of some important effects driving sea level rise is too limited, [the IPCC 2007] report does not assess the likelihood, nor provide a best estimate or an upper bound for sea level rise."

Recent research has used alternate approaches to explore further the issue of global sea-level change. Their results are presented above for the year 2100 (references are provided below).

The curves used in EC 1165-2-211 are comparable to the results of the recent research.

References:
NRC 1987. Responding to Changes in Sea Level, Engineering Implications, Committee on Engineering Implications of Changes in Relative Mean Sea Level, Marine Board, Commission on Engineering and Technical Systems, National Research Council. National Academy Press, Washington DC 1987, 148pp.

IPCC 2001. Climate Change 2001: The Scientific Basis, edited by J.T. Houghton et al., Cambridge University Press, Cambridge, U.K.

IPCC 2007. Climate Change 2007: The Physical Science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, edited by S. Solomon et al., Cambridge University press, Cambridge U.K.

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Horton, R., et al., 2008. Sea level rise projections for current generation CGCMs based on the semi-empirical method, Geophysical Research Letters, Vol. 35, L02715, 2008.

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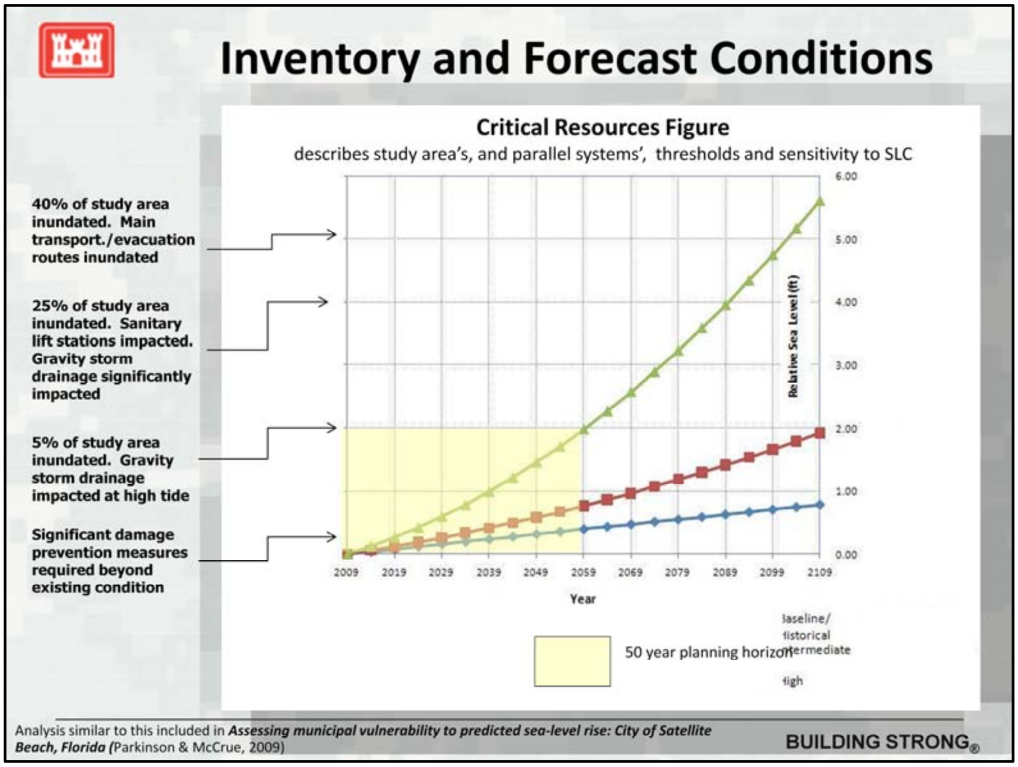
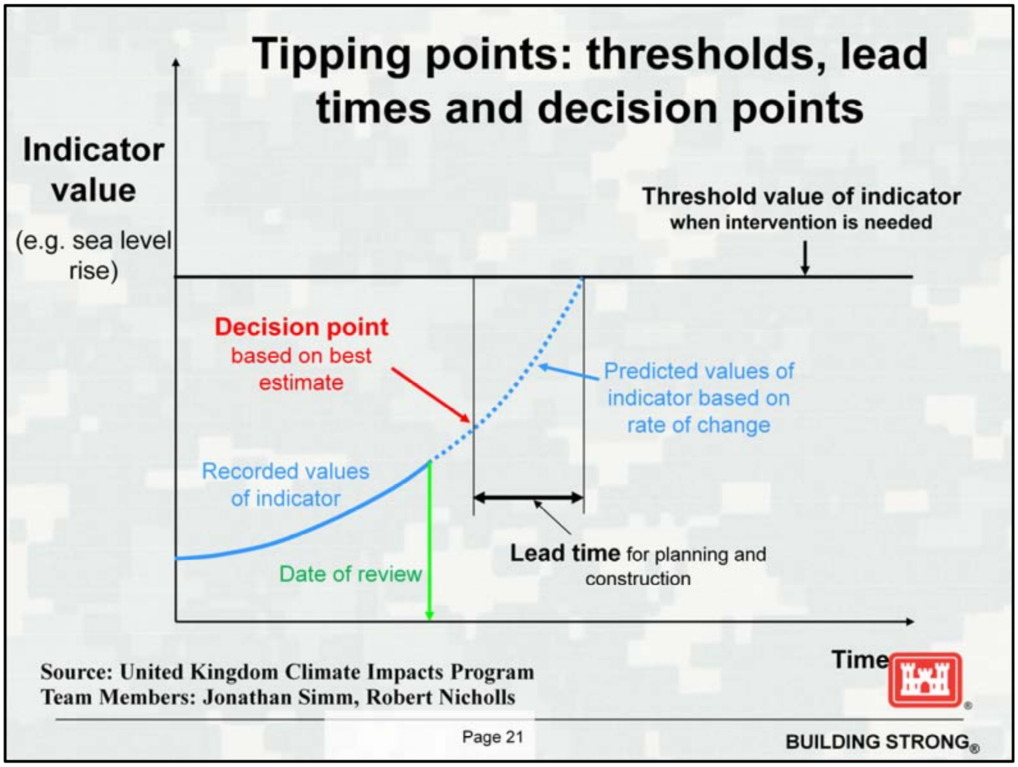
Jevrejeva, S., et al., 2010. How will sea level respond to changes in natural and anthropogenic forcings by 2100?, Geophysical Research Letters, Vol. 37, L07703, 2010.



Potential approach to develop alternatives:

- Start with the period of analysis
- Consider a longer planning horizon (reflects commitment by project sponsor)
- ID critical stages (dashed lines)
- Next, ID structural and nonstructural responses and estimate lead times necessary



Key approach here is to identify key thresholds:

- Foredune, backshore elevation
- Levee or floodwall elevation
- Maintainable coastal structure elevation.

It is important to identify the lead time required which is tied to the rate of sea level change and work backward using that time to incorporate time for study, funding, and construction.

This approach would identify important decision points in the project life.

Potential approach to develop alternatives:

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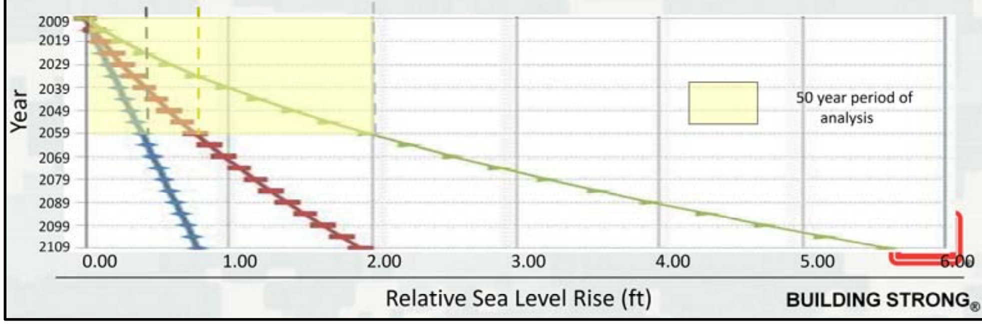

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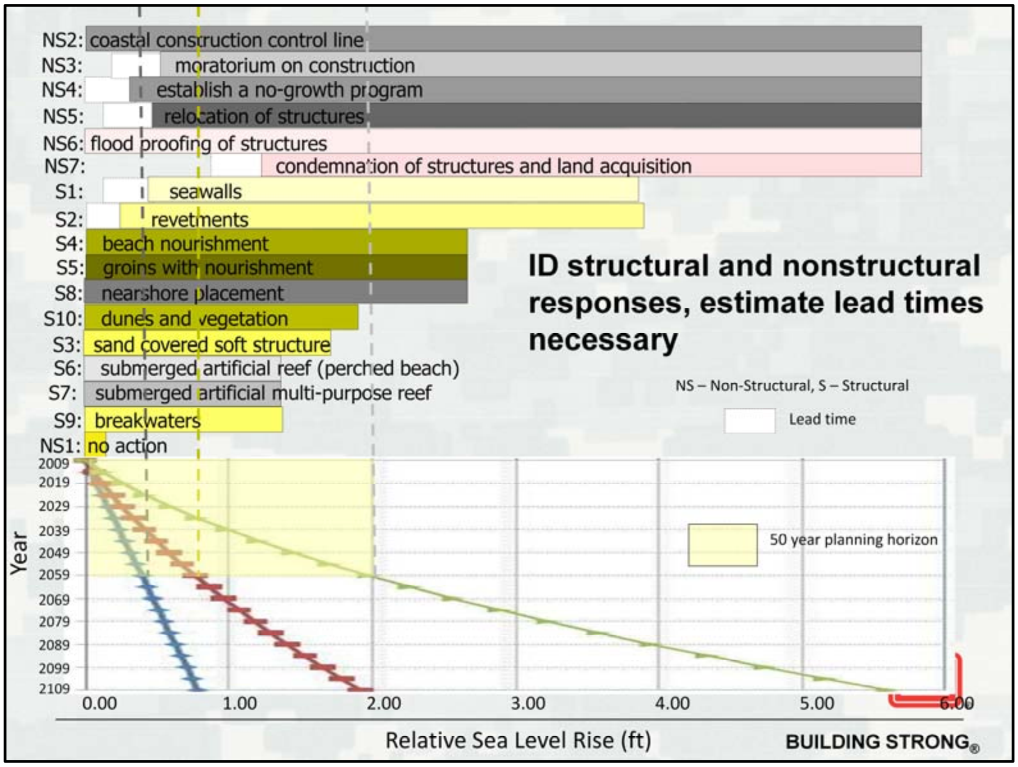
NS2: coastal construction control line
NS3: moratorium on construction
NS4: establish a no-growth program
NS5: relocation of structures
NS6: flood proofing of structures
NS7: condemnation of structures and land acquisition
S1: seawalls
S2: revetments
S4: beach nourishment
S5: groins with nourishment
S8: nearshore placement
S10: dunes and vegetation
S3: sand covered soft structure
S6: submerged artificial reef (perched beach)
S7: submerged artificial multi-purpose reef
S9: breakwaters
NS1: no action
ID structural and nonstructural responses, estimate lead times necessary
NS – Non-Structural, S – Structural
Lead time
50 year planning horizon
Year
2009
2019
2029
2039
2049
2059
2069
2079
2089
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2109
0.00
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Relative Sea Level Rise (ft)
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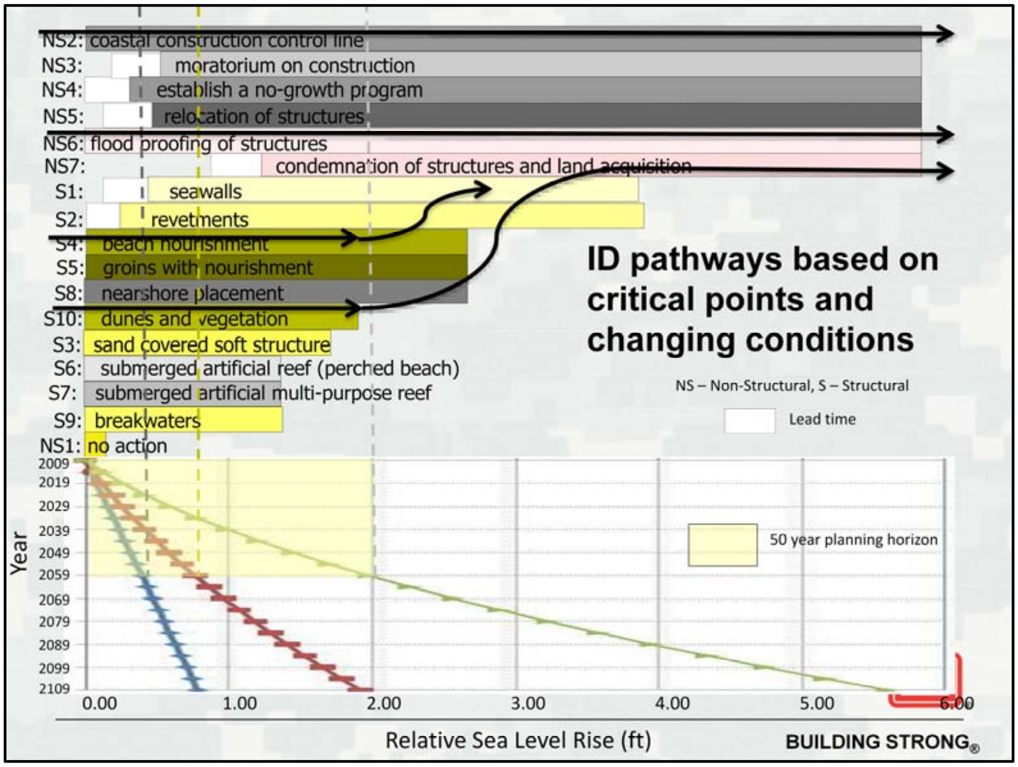

NS2: coastal construction control line
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S7: submerged artificial multi-purpose reef
S9: breakwaters
NS1: no action
ID pathways based on critical points and changing conditions
NS – Non-Structural, S – Structural
Lead time
50 year planning horizon
Year
2009
2019
2029
2039
2049
2059
2069
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Relative Sea Level Rise (ft)
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Adaptation pilots

- USACE is conducting climate change adaptation pilots:
  - To test the suggested flexible framework for federal agency climate change adaptation at the project level
  - To explore USACE adaptation issues
- An unexpected benefit has been the rapid increase in learning and knowledge sharing by district staff leading and participating in the pilots

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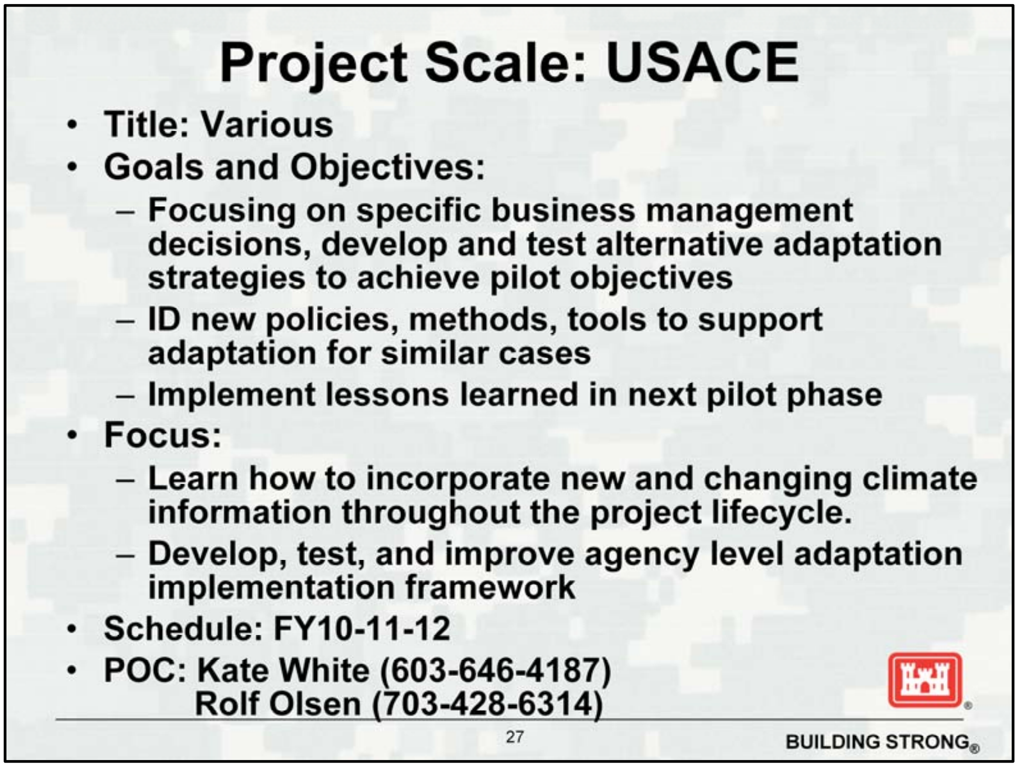
In Progress: Adaptation Pilots

- Four agencies conducted CEQ climate change adaptation pilots at different scales:
  - Agency level: DHS
  - Agency component level: DOT FHWA
  - Statewide Level: EPA at the statewide level (FEMA joined, USACE participated as well)
  - Project level: USACE
- General results presented first
- More detailed USACE results follow



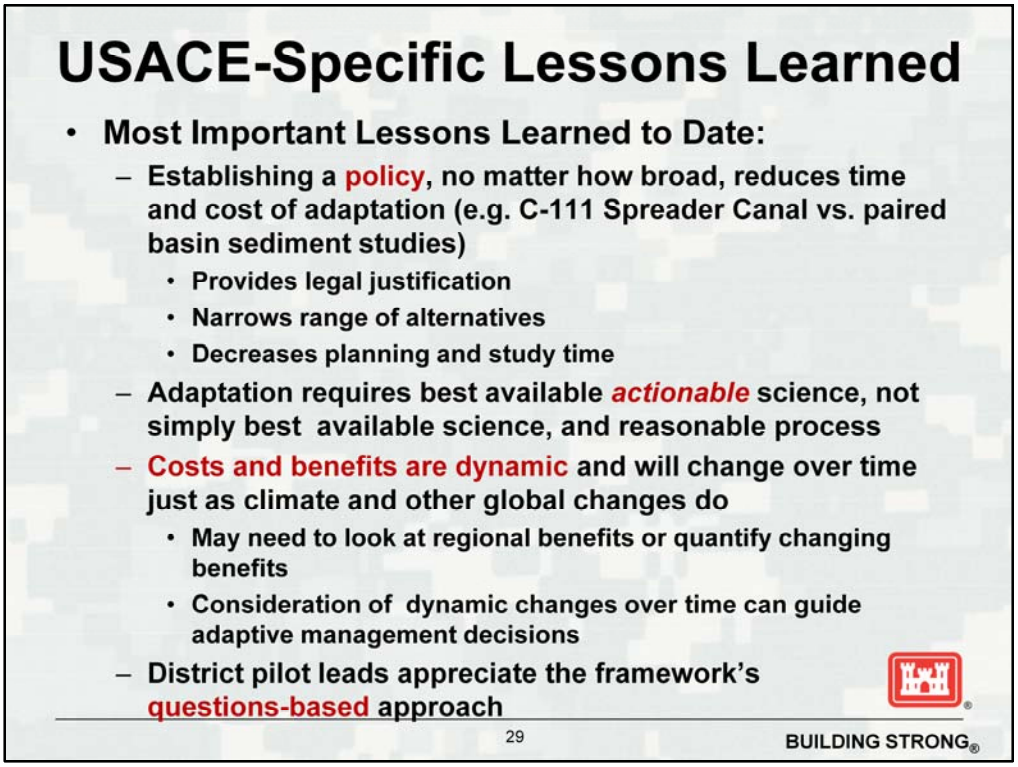
The Council on Environmental Quality's Interagency Task Force on Climate Change Adaptation proposed a flexible framework for federal agency climate change adaptation.

Four agencies conducted pilots:

DHS at the agency level
DOT FHWA at the agency component level
EPA at the statewide level (FEMA joined and USACE participated as well)
USACE at the project level

Lessons Learned

- **Project Scale (USACE):**
  - Local or project-level application of the framework often concentrates on one or two aspects of the framework
  - The development and use of consistent national and regional climate scenarios is critical to support local or project level implementation of the framework.
  - Time and cost to study climate impacts and apply them to mission and operations are orders of magnitude higher than for agency-level planning
  - Actual implementation takes additional time for adaptation options that involve stakeholder collaboration, engineering and design, construction, permitting, environmental impact assessments
  - The CEQ adaptation framework is adaptable and general enough to be applied to existing projects at any step



Based on our project-level pilots, these are our most important lessons-learned to date.

FY10 Pilot: C111 Spreader Canal

- Phase: Planning, Engineering, and Construction (Pilot Complete)
- Team Lead: Glenn Landers (CESAJ)
- Background: Ecosystem restoration project to restore marsh hydroperiod is impacted by sea-level rise. EC 1165-2-211 used to ID future local relative sea-level change scenarios.
- Central question for this pilot: "How do we allow for shoreline retreat to preserve critical tidal and near-shore ecosystems in a long-term regional planning context?"
- Approach: Address questions of long-term benefits at project vs. regional levels. ID potential shoreline changes and geographic location shifts to areas that may be able to produce the desired natural ecosystem services.
- Lessons Learned to Date:
  - Mean High High Water (MHHW) is a better indicator than mean sea level (MSL) for transition from freshwater to saltwater ecosystems
  - Benefits are dynamic: shoreline retreat can preserve critical tidal and near shore ecosystems
  - Simple GIS-created inundation maps are adequate for planning studies given the uncertainties of topographic information, water supply and habitat response.
- Key Result: Concept of dynamic benefits (in space and time)
- RCC POC: Dr. Kate White

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FY10 Pilots: Reservoir Sedimentation

- Title: Climate Change Impact on Reservoir Capacity & Water Supply Reliability (Pilot 75%)
- Phase: E&C and O&M
- USACE Leads: Doug Clemetson (CENWO-ED-HD) and Jud Lee (CESPA-PM-LH)
- Background: Projected climate change impacts to hydrology may change future sediment supply, thus affecting the life expectancy of reservoirs
- Central Question: "How will changing climate affect reservoir sedimentation?"
- Approach: This joint Reclamation-USACE study is looking at paired reservoirs: USACE's (a) Garrison Reservoir in ND and (b) Cochiti Reservoir in NM and Reclamation's (a) Bighorn Lake in MT and WY and (b) Elephant Butte Reservoir in NM.
  - A downscaling approach serves as input to existing operations models to assess how projected hydrology and reservoir sedimentation might impact water storage reliability under otherwise existing operating conditions.
  - Results can be used to a) predict the life of a reservoir, b) apply better management of the reservoir to extend life expectancy under climate change, and c) assist in decisions on whether additional analysis is needed.
  - This pilot concentrates on flexible framework step 2 (Understand how climate is changing), step 3 (Apply to mission and operations), and step 6 (Build awareness and capacity).
- Lessons Learned to Date:
  - The method proposed to estimate climate change was inadequate at regional and local scale.
  - Results will be used in a FY11-12 adaptation pilot in a snow-dominated watershed
- Key Result: Lack of established method and guidance results in higher than expected costs and longer time
- RCC POC: Dr. Kate White and Dr. Rolf Olsen

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FY10-11 Pilot: Coralville Reservoir

- Title: Coralville Reservoir Climate Change Assessment
- Phase: Operations and Maintenance (Pilot 50%)
- Team Leads: Kevin Landwehr (CEMVR-EC-HH)
- Background: Coralville Reservoir is a multipurpose U.S. Army Corps of Engineers (USACE) reservoir on the Iowa River with authorized purposes of flood risk reduction, fish and wildlife, water quality, and recreation. This pilot study will develop methods and plans to assess and improve the robustness of reservoir operations in the context of climate change.
- Central question: "How do we incorporate climate change considerations into reservoir operating policies that will be robust and adaptable to potential climate changes?"
- Approach: The team is working with regional climate scientists to develop future climate change scenarios that will be used to test the robustness of alternative plans and reservoir operating policies. This pilot complements CEQ EPA Pilot (Rebuilding Iowa). The USACE Silver Jackets, a component of the Flood Risk Management Program, are involved in this pilot to support interagency coordination in floodplain management and emergency response. The same climate team is being used by both pilots. Will be extended to the Iowa-Cedar integrated water resources management (IWRM) study in FY11.
- Lessons Learned to Date: The framework forced us to step back, answer questions, take a large look at the problems and solutions: this is a good thing
- Key Result: Framework supports holistic thinking
- RCC POC: Dr. Rolf Olsen

FY10-11 Pilot: NIDIS

- Title: NIDIS Pilot Study: Southeast U.S. Apalachicola-Chattahoochee-Flint Pilot Study (Pilot 35%, depends on other agency schedules)
- Phase: Planning and O&M
- USACE Lead: James Hathorn (SAM)
- Background: More frequent and severe droughts are possible with climate change. Water managers will need tools to better assess and communicate drought conditions in order to better implement adaptive measures.
- Central Question: "What information is needed for monitoring and assessing drought for water management decision making? How should this information be communicated to stakeholders?"
- Approach:
  - This pilot would leverage a National Integrated Drought Information System (NIDIS) project in its beginning phases. The NOAA-led interagency effort will develop a drought information system for "better informed and more timely drought-related decisions, leading to reduced impacts and costs."
  - The objective of USACE participation in this NIDIS pilot study is to develop tools to meet a SAM-identified need to assist the district and stakeholders in the basin to agree on current drought conditions, prior to developing and evaluating adaptation alternatives.
  - This pilot concentrates on flexible framework step 2 (Understand how climate is changing) and step 6 (Build awareness and capacity).
- Key Result: Climate communication counts
- RCC POC: Dr. Rolf Olsen

FY10-11 Pilot: Willoughby Spit and Vicinity

- Phase: General Reevaluation Report (GRR) Phase (Pilot 15%)
- Team Lead: Jeff Strahan (CENAO-PM-PR)
- Background: Willoughby Spit in Norfolk has some reaches affected by back bay flooding, which will become worse over time as sea level changes. The November 2009 Northeaster caused back bay flooding and overwash, highlighting the need to explore future vulnerabilities.
- Central question for this pilot: "At what point will back bay flooding in certain portions of the beach decrease benefits to the point that beach renourishment is unjustified in those locations?"
- Approach:
  - We will use the EC 1165-2-211 guidance on sea-level change to project future conditions to identify vulnerabilities that impact the beach renourishment cycle.
  - This pilot also involves the Coastal Planning Center of Expertise so we can develop a model for involving PCXs in climate change adaptation.
- **Key Result: Need for future creative solutions and incentives that recognize realities of retreat**
- RCC Rep: Dr. Kate White

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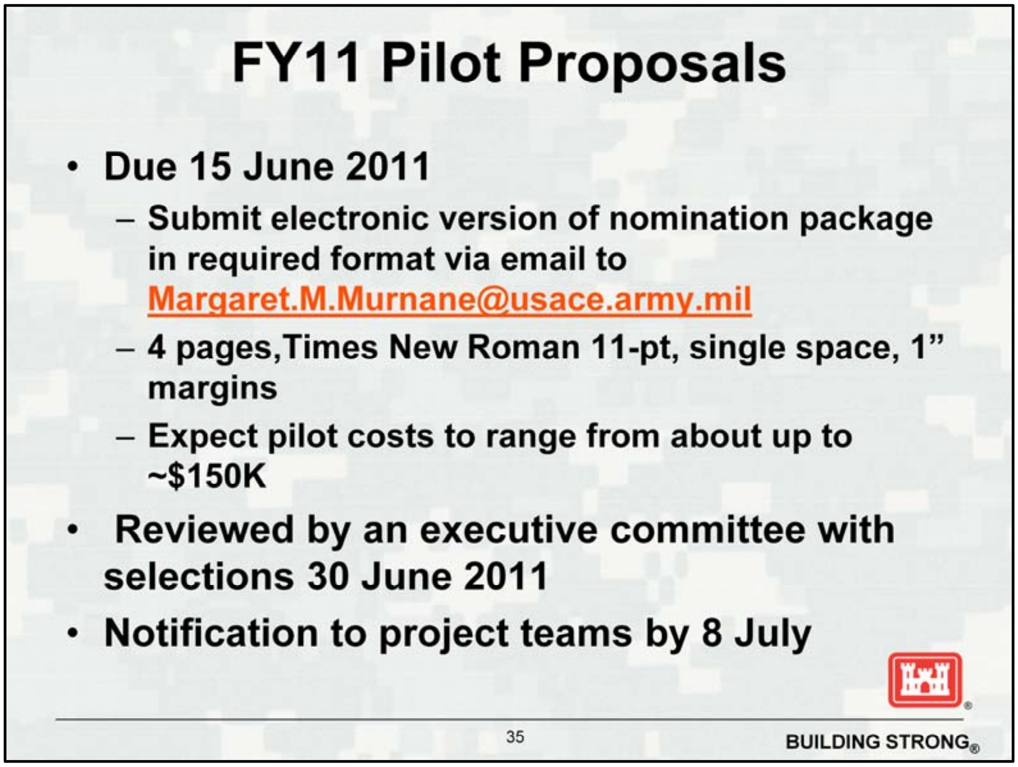

The pilot studies for FY11 will focus on evaluating and testing approaches, frameworks, and guidance for incorporating climate change into USACE District life cycle decision making including planning, engineering, operations, and rehabilitation. Priorities for FY11 include the following type of studies:

Pilot studies to evaluate the framework described in the Risk-Informed Decision-Making (RIDM) for Climate Change white paper.
Pilot studies to support the Sea Level Change Civil Works Technical Letter.
Pilot studies that test the lesions learned from the FY10 workshops on nonstationarity and the portfolio of approaches to developing climate information..
Joint work with other federal agencies, states, tribes and local governments on climate change topics.
Pilot studies to support regional collaboration and solve regional climate change problems.
Pilot studies that support and use Integrated Water Resources Management (IWRM) as a framework for climate change adaptation within a watershed or river basin.
Vulnerability assessments of USACE projects and/or systems of projects.
Regional assessments on USACE missions done cooperatively with regional science agencies and stakeholders.

Nominations for pilot studies for FY11 funding are currently being solicited. Due to the length of the FY11 Continuing Resolution, we have a short deadline for nominations for projects beginning in FY11 (COB 15 June 2011). The nominations will be reviewed by an executive committee approved by Mr. James Dalton, Chief, Engineering & Construction and Mr. Tab Brown, Chief, Planning and Policy Division. The committee may include Rennie Sherman, the HQ proponent for RCC, and Jerry Webb, the Chief HH&C CoP, and Civil Works deputies (or their designees), supported by IWR staff. The first selections should be made by 30 June 2011, with notification to project teams by 8 July 2011.

Next Steps (Next Webinar)

- Nationwide screening-level climate change assessment of the vulnerability of CW missions, operations, programs, and projects to climate change and variability
- Integration of adaptation and mitigation
- Progress on climate guidance

Summary

- Climate change adaptation is an active area for the USACE CW program because of lessons-learned from Hurricane Katrina and observed hydrologic and sea-level changes
- The climate change commitment requires both adaptation and mitigation
- Adaptation is challenging and has a longer time frame, but we are making progress
  - Pilots provide new knowledge
  - District-led guidance updates develop new knowledge
- More to come!

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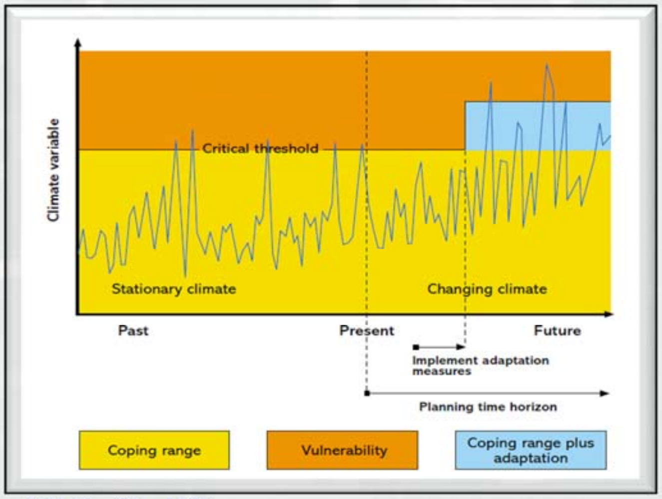
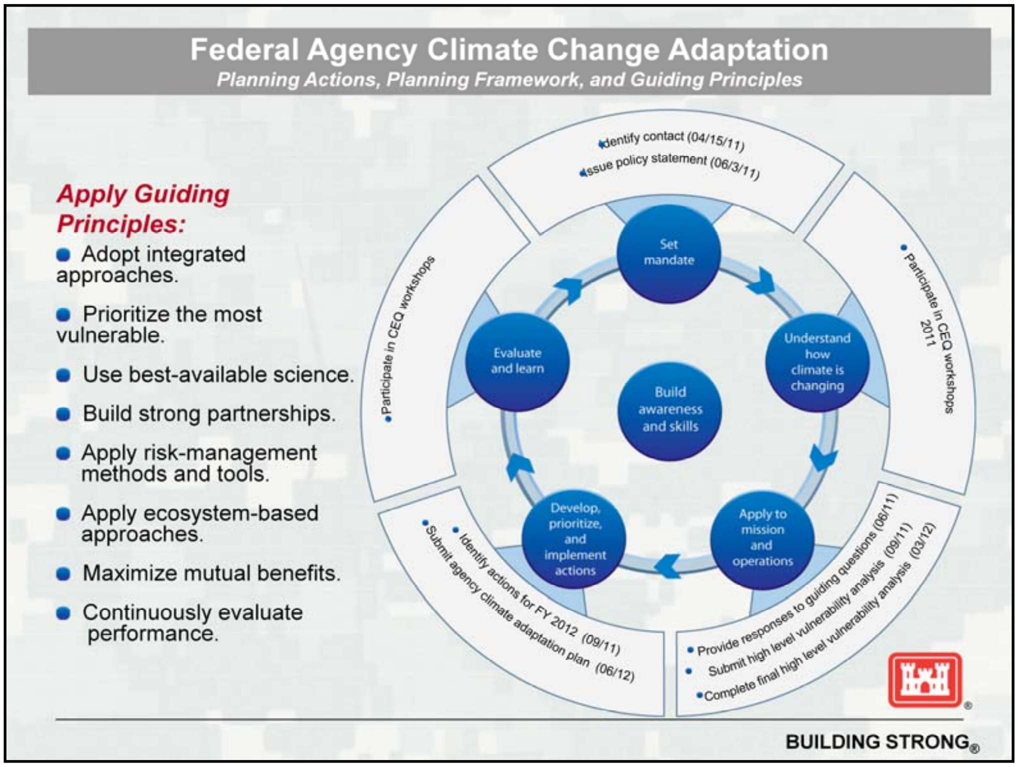
Background Slides

Managing USACE Resources Under Climate Change Means Explicitly Characterizing Their Vulnerabilities



UKCIP: Willows & Connell, 2003

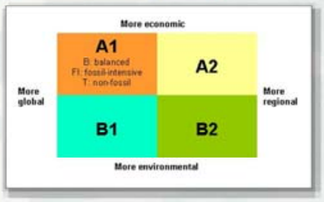


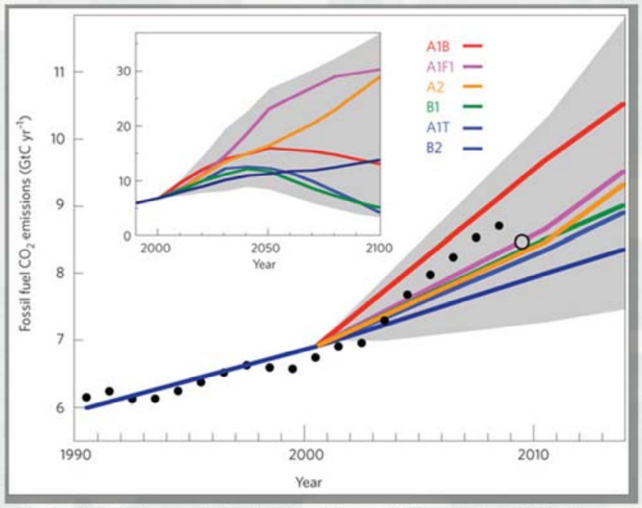
This is just a snapshot of what's coming over the next few years from the Implementing Instructions promulgated by CEQ/OFEE and OMB in March 2011.

Remember, this is expected to be an iterative processes as the agencies learn and understand more about climate impacts, vulnerabilities, and adaptation.

The guiding principles for adaptation are in line with USACE Campaign Plan goals and objectives.

Background: IPCC Scenarios

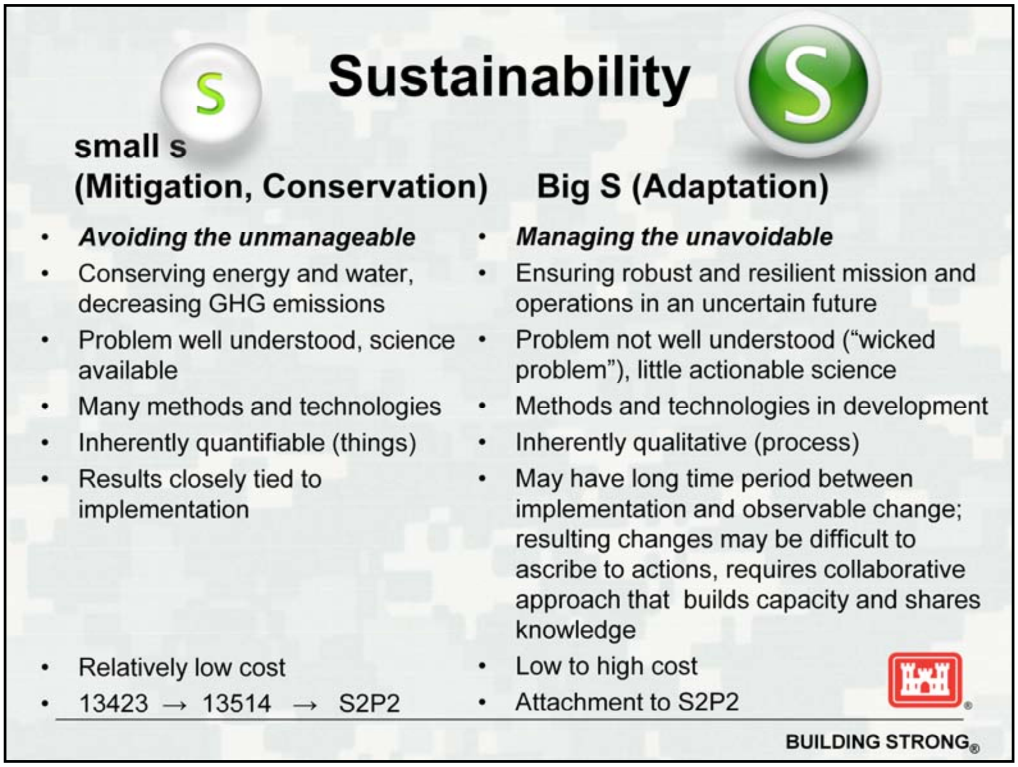




Manning et al 2010 "Misrepresentation of the IPCC CO_2 emission scenarios" *Nature Geoscience* 3, 376 - 377

Integrating Adaptation and Mitigation

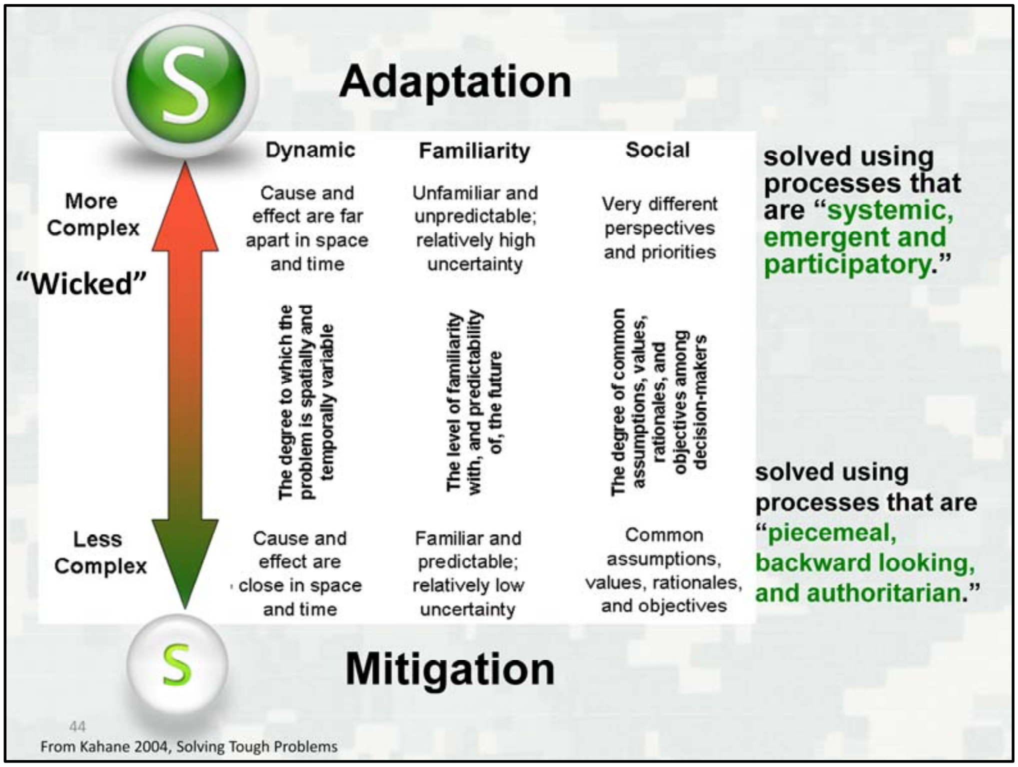
- **Adaptation: Successfully perform our missions, operations, programs, and projects in an increasingly dynamic physical, socioeconomic, and political environment**
- **Mitigation: Increase our water and energy efficiency while reducing GHG emissions**
- **Investments must be integrated**
  - **so that we don't implement near-term mitigation measures now that will be overcome by longer-term climate impacts requiring adaptation**
  - **Or that a short-term mitigation action forestalls a longer-term adaptation action**



Why is adaptation different from mitigation? Climate change adaptation is inherently different in many ways from mitigation/conservation.

For example:

Adaptation problems are more complex and interconnected in ways that we do not yet understand
They will require totally different skill sets and knowledge
The methods and approaches not well understood
Cause and effect may be far apart in time and space, complicating analyses
The results are not easily quantified with current knowledge
Science translation is a critical and important ongoing process
Monitoring and adjustment will be necessary for many adaptation actions
Implementation scale (time, cost, realization of outcomes) is very different
Emphasis on short-term, accounting-type approach comes at cost to long-term social, environmental, and economic equity, which is a cornerstone of effective adaptation



It's not just either-or, though. There's a connection between adaptation and mitigation, and that's one reason why integrating them is important.

For example, as we develop more detailed information about sea-level changes and how to plan and adapt to these changes, we are moving from the red, "wicked" problem area into the less complex problem area.

Similarly, there may be mitigation decisions, especially when we begin to look at the sub-MSC level, that present a host of inter-relationships and unintended consequences which move these more into the "wicked" problem category.

What Participants Learned (1)

- We learned how to evaluate **potential impacts of climate change on the sediment yield** to a large project and further defined the link between sediment and temperature
- We learned about **statistical downscaling** of data from 112 different Global Circulation Models and how to apply to the pilot region
- My favorite quote is "we can spend megabucks on climate research... and still not answer the questions," emphasizing the need to bring the discussion back to the **need for actionable science**
- This helps us to begin to build a **framework for a more informed approach** to dealing with future challenges (i.e., flooding) we're likely to face

What Participants Learned (2)

- Climate impacts with respect to sediment are challenging concepts to evaluate, but we learned how to incorporate considerations for climate change with regional sediment management concepts
- We learned that all future climate scenarios analyzed for our pilot basin result in increases in future runoff and flows
- We learned that model error can result in larger impact than the impact of future climate change and bias correcting is necessary
- We have learned a lot about what other agencies are doing in regard to climate change
- We now have a far better understanding of the content, variability, and limitations of the available climate data

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What Participants Learned (3)

- Although the study is not complete yet, preliminary results of this study indicate that we need to be prepared for future flow increases in our pilot basin which can affect **system reservoir operation**
- We are far better prepared to intelligently respond to questions regarding climate change from project sponsors and stakeholders by being **prepared to address the substance of the questions**
- In recently updating **flow frequency estimates** in the pilot area, there's the recognition that in using the period of record, the estimates are being heavily influenced by the drier, early part of the record which aren't necessarily reflective of what we've experienced the last several decades

What Participants Learned (4)

- We learned a viable method to **translate possible climate change scenarios into a "real" engineering model** –something I had a hard time understanding when we started – I believe we have done that and am proud to have been part of the project
- I can see how using the VIC model and possible future climate projections would be very beneficial to not only analyzing our **river systems but for our levee and dam designs** as well
- I think applying a climate change aspect to the **design process** has merit and can see us doing that in the future

What Participants Learned (5)

- I have really enjoyed working on a project that is more complex and not as "black and white" as a lot of our CW and MP projects can be
- The technical exchange associated with this pilot has greatly contributed to methods and study quality
- I have also appreciated working with the other Corps Districts as well, learning from the processes they used in their studies and applied some of that to what we did in ours
- The work we did alongside Reclamation was both innovative and simple to understand, even for someone that doesn't have a lot of analytical experience with the subject, like myself

How Participants Share This Knowledge (1)

- We have made presentations about the pilot study at the **MSC H&H CoP** meeting
- We presented information about the study to two large ongoing basin-wide plus an Interagency **Climate Change workshop** sponsored by NOAA
- We will be giving a presentation at the 2011 Corps **Infrastructure Systems Conference** in Atlanta
- We have applied what we've learned **to other projects** including ongoing studies in several other river basins and in future projects
- We have developed a good working **relationship with the Bureau of Reclamation** while working on this project

How Participants Share This Knowledge (2)

- We have collaborated with several COE Districts and Reclamation during this pilot, expanding our technical network
- We gave a conference presentation on the pilot project
- We are sharing our knowledge within the Corps through the infrastructure conference and through future lunch-n-learn style presentations at the District
- I have shared some of our process and findings with the local University and the Fish and Wildlife Service