Implementing Socio-Ecological Resilience into Floodplain Planning, Design, & Capital Projects

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Skagit Valley
Skagit Valley

From: Eric Grossman, USGS
Baseline conditions are shifting

- Climate change is shifting
- Rivers, landscapes, shorelines, and species adapting in real time to these shifts
- New technologies, resource scarcities, and population growth are changing our capabilities
“A new dark age looms”
“A new dark age looms” NYTimes

- We design buildings and infrastructure to mitigate risk
- We use lessons from our elders
- Yet there is something dreadfully wrong with the world
“The Last Time CO2 Was This High, Humans Didn’t Exist”

“Mitochondrial Eve”: single ancestor to all humans?

Credit: Scripps Institution of Oceanography
STATIONARITY

In Loving Memory

Milly et al, 2008
But that’s not our training!

Risk = Probability X Consequences
# ADAPTING TO CHANGE

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<thead>
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Modymeyer, 2017
### Stationarity is Dead

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### It just keeps going...

- **Rokstrom**: Stationarity is dead and new and different stable states (basins of attraction) may emerge
- **Snowden & Boone Leader's Framework for Decision-making**: Simplified
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SOCIO-ECOLOGICAL RESILIENCE:

It’s not how often it breaks – it’s how long it takes to recover.
(Holling, 1986)
Adaptive Cycle
Resist
Adapt
Transform
Adapt
Resilient Design Performance Standard for Infrastructure and Dependent Facilities
What The Standard can do...

Leverage every capital project as an opportunity to incrementally move Boulder County towards a more resilient future.
## RESILIENT DESIGN PERFORMANCE STANDARD

### Score Sheet

<table>
<thead>
<tr>
<th>BOULDER COUNTY INDICATOR</th>
<th>POINTS</th>
<th>ENTER SCORE</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td><strong>1. Co-Benefits.</strong> Provide solutions that address problems across multiple sectors creating maximum benefit.</td>
<td></td>
<td></td>
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<tr>
<td>Indicator 1.1. Apply a business case format that includes consideration of alternatives and robust analysis of those alternatives across the triple bottom line of economics, community, and the environment.</td>
<td>Required</td>
<td>Required</td>
<td>Prepare a business case that takes an analytical look at the project element alternatives, the costs, and the return on investment both in terms of the economy and in value creation to the community and the environment.</td>
</tr>
<tr>
<td>Indicator 1.2. Use multi-disciplinary design team to develop and consider a range of integrated solutions that provide enhanced value across the triple bottom line.</td>
<td>2</td>
<td></td>
<td>Document the project design charrette process, integrated design team in Business Case.</td>
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<tr>
<td><strong>2. High Risk and Vulnerability.</strong> Ensure that strategies directly address the reduction of risk to human well-being, physical infrastructure, and natural systems.</td>
<td></td>
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<td>Indicator 2.1. Satisfy the time-to-recovery performance goal.</td>
<td>Required</td>
<td>Required</td>
<td>Refer to Time-to-Recovery Performance Goals Matrix (Design team estimate the damage from hazard and the time-to-repair.)</td>
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<td>Indicator 2.2. Identify gaps and find solutions for moving forward.</td>
<td>Required</td>
<td>Required</td>
<td>If the project cannot meet the performance goals, then the project team must develop temporary work-arounds or programmatic strategies to meet the required Operational time-to-performance goal.</td>
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<td>Indicator 2.3. Consider project alternatives that augment existing capabilities.</td>
<td>Required</td>
<td>Required</td>
<td>Provide business case that documents consideration and analysis of alternatives considered for the project. (Can include temporary repairs to meet the minimal or operational phase.)</td>
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### Indicator 7.6. Consider if project can be completed within the capacity of reserves at each scale so isolated elements can survive for a period on their own.

### Indicator 7.7. Evaluate potential of creating semi-autonomous systems at the building, neighborhood, and district scale.

#### Indicator 8.1. Identify project design solutions that leverage and enhance the function of existing natural, social, and infrastructure systems.

#### Indicator 9.1. Account for value of benefit to future generations when identifying preferred project designs.

#### 8. Harmonize with existing activity. Expand, enhance, or leverage work being done to build on existing efforts. Assure outcomes that are environmentally friendly, sustainable, and complementary to the natural setting.

#### 19. Long Term Lasting Impact. Create long term gains to the community with solutions that are replicable and sustainable, creating benefits for present and future generations.

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### Total Possible Points

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<th>Project TOTAL</th>
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<td>23</td>
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In meeting or exceeding the resilience performance standard of 18 points the project is contributing towards resilience by meeting the Time-to-Recovery goal. To better reflect the multi-generational investments OMB Circular A-4 recommends applying a 1% discount rate in the economic analysis for future generations, 3% for a consumption perspective, and 7% discount rates to model an investment perspective. Document findings in the Business Case. For more information visit bccollaborative.org/infrastructure-policies.html.
ATTRIBUTES OF SOCIO-ECOLOGICAL RESILIENCE

- Diversity
- Modularity
- Connectivity
- Storage
- Feedback
- Story
- Trust
- Self-Organizing

Image: USGS
DIFFERENCE FROM TRADITIONAL ENGINEERED RESILIENCE PLANNING

1. Uses *time-to-recovery*
2. Accounts for increased *variability from climate change*
3. Reveals *interdependencies* between infrastructure systems
4. Reflects the *nexus between built and natural systems*
5. Identifies *community-based priorities*
6. Avoids “*scale blindness*”
7. Rewards *flexibility and adaptability*
8. Incorporates *social equity and capacity to adapt*
THE COPENHAGEN EXAMPLE
COPENHAGEN
Strategic Urban Flood Plan
Catchment: Ladegårds Å og Vesterbro

01 Park
Hans Tavsens

02 Plaza
Blågårds Plads

03 Street
Korsgade

04 Green Street
Svend Trøsts Vej

05 Urban Canal
Vodrofsvej

06 Urban Creek
Gasværksvej

07 Retention Boulevard
Istegade

08 Boulevard
Sønderboulevard

© Atelier Dreiseitl
COPENHAGEN STRATEGIC FLOOD MASTERPLAN

© Atelier Dreiseitl
It’s not complicated. It’s complex.
We can do this.
Thank You!

Steve Moddemeyer
Principal
CollinsWoerman
smoddemeyer@collinswoerman.com
Climate change undermines a basic assumption that historically has facilitated management of water supplies, demands, and risks.

**Stationarity Is Dead: Whither Water Management?**

P. C. D. Milly, Julio Betancourt, Malin Falkenmark, Robert M. Hesse, Zhiguo W. Kundzewicz, Dennis P. Lettenmaier, Ronald J. Stuuffer

Systems for management of water throughout the developed world have been designed and operated under the assumption of stationarity. Stationarity—the idea that natural systems fluctuate within an unchanging envelope of variability—is a foundational concept that permeates training and practice in water-resource engineering. It implies that any variable (e.g., annual streamflow or annual flood peak) has a time-invariant (or 1-year-periodic) probability density function (pdf), whose properties can be estimated from the instrument record. Under stationarity, pdf estimation errors are acknowledged but have been assumed to be reducible by additional observations, more efficient estimators, or regional or paleohydrologic data. The pdfs, in turn, are used to evaluate and manage risks to water supplies, waterfloodplains; annual global investment in water infrastructure exceeds trillion dollars; and annual global investment in water infrastructure exceeds trillion dollars.

In view of the magnitude and ubiquity of the hydroclimatic change apparently now under way, however, we assert that stationarity no longer serves as a central, risk-management tool in water planning. Because risk management in water planning engages not only the distribution of risk but also the management of extreme events, knowledge of the distribution of climate extremes is critical. The extreme events that are most important to society (e.g., droughts, floods, and wildfires) will become more frequent and severe with climate change under any choice of emissions. Climate model projections show increases in global average temperature and changes in the distribution of precipitation extremes.
10% Probability of Exceedance in 50 years

Code is not enough
2%
Probability of Exceedance in 50 years

Code is not enough
Adapt
Thank you!!

STEVE MODDEMeyer
COLLINSWOERMAn
206.245.2034
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‘There Are No Good Options In Syria,’ Sighs Man Who Has Devoted 12 Minutes Of Research To Topic
Atmospheric CO₂ at Mauna Loa Observatory

Scripps Institution of Oceanography
NOAA Earth System Research Laboratory

PARTS PER MILLION


YEAR

September 2016
ENGINEERED RESILIENCE:
HOW OFTEN DOES IT BREAK?

Today's 100-year drought

Today's 100-year flood
ENGINEERED RESILIENCE:
HOW OFTEN DOES IT BREAK?
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Today’s 100-year drought

Today’s 100-year flood

Tomorrow’s new 100-year flood?
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Today’s 100-year flood
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Range of possible 100-year droughts?

Range of possible 100-year floods?
LIVABILITY, HEALTHY ECOSYSTEMS, ECONOMIC VITALITY ARE LINKED