A "Sea to Summit to Sea" Approach to Improve Management of Water Resources

Lynn E. Johnson
A "Sea to Summit to Sea" Approach to Improve Management of Water Resources

- San Francisco Bay Area Stakeholders and Collaborators
- Sea-to-Summit-to-Sea Integrated Monitoring, Analysis, and Prediction System
- Water Management Interfaces
  - Reduce Flood Damages With Increased Lead Time
  - Enhance NWS WFO Flash Flood Warning Services With Distributed Hydrologic Model
  - Enhance Water Supply With Reservoir Forecast-based Operations (FBO)
  - Reduce Combined Sewer Discharges With Advanced Precipitation Forecasting
  - Enhance Endangered Fisheries Habitat With Coupled Water Management Modeling
- Forecast Benefits Assessment
Stakeholders and Collaborators

• Federal
  ▪ National Weather Service
    • California-Nevada River Forecast Center
    • San Francisco – Monterey Weather Forecast Office
    • NWS National Water Center
  ▪ National Marine Fisheries Service
  ▪ National Ocean Service
  ▪ US Army Corps of Engineers
  ▪ US Geological Survey
  ▪ Federal Emergency Management Agency

• State and Local
  ▪ California Department of Water Resources
  ▪ Sonoma County Water Agency
  ▪ Scripps Center for Western Weather and Water Extremes
  ▪ Mendocino County Russian River Flood Control District
  ▪ San Francisco Public Utilities Commission
  ▪ Santa Clara County Water Agency
  ▪ Bay Area Flood Protection Agencies Association
  ▪ San Francisco Estuary Partnership
## TIME FRAMES AND WATER MANAGEMENT PURPOSES

<table>
<thead>
<tr>
<th>Time Frame / Purpose</th>
<th>Nowcast (0 min – 6 hrs)</th>
<th>Near Real-time (6 hr – 1 day)</th>
<th>Short-term (1 day – 1 week)</th>
<th>Near-term (1 wk – 3 mon)</th>
<th>Mid-term (6 mon – 2 yrs)</th>
<th>Long-term (5 years+)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flood Mitigation</strong></td>
<td>Flood status assessment</td>
<td>FF warning; Response deploy; System opt.</td>
<td>Flood warning; Response deploy; Reservoir FBO</td>
<td>Flood warning; Response deploy; Reservoir FBO</td>
<td>Over-year storage allocation</td>
<td>Flood frequency; Capacity deelv; Climate adapt.</td>
</tr>
<tr>
<td><strong>Water Supply</strong></td>
<td>Status assessment; Intake operations</td>
<td>Intake and outlet operations</td>
<td>Reservoir FBO; Emergency conservation</td>
<td>Delivery sched.; Reservoir FBO; Conservation</td>
<td>Over-year drought mit.; Conservation</td>
<td>Capacity deelv; Demand mana; Climate mana adapt.</td>
</tr>
<tr>
<td><strong>Hydro-Power</strong></td>
<td>Release operations</td>
<td>Reservoir FBO</td>
<td>Reservoir FBO; Demand sched.</td>
<td>Reservoir FBO; Demand sched.</td>
<td>Over-year drought mit.</td>
<td>Capacity deelv.; Climate adapt.</td>
</tr>
<tr>
<td><strong>Ecosystem Enhancement</strong></td>
<td>Status assessment</td>
<td>Threat assess; River &amp; Reservoir FBO</td>
<td>Threat assess; River &amp; Reservoir FBO</td>
<td>Threat assess; River &amp; Reservoir FBO</td>
<td>Threat assess; Capacity deelv; Drought mit.</td>
<td>Ecosystem &amp; Capacity deelv; Climate adapt.</td>
</tr>
<tr>
<td><strong>Water Quality</strong></td>
<td>Status assess; Real-time control</td>
<td>WW capture &amp; treatment</td>
<td>Threat assess; Sys. optimize</td>
<td>Threat assess; Capacity deelv; Sys. optimize</td>
<td>Threat assess; Capacity deelv; Sys. optimize</td>
<td>Capacity deelv; Climate adapt.</td>
</tr>
<tr>
<td><strong>Recreation</strong></td>
<td>Weather status; Warning</td>
<td>Event scheduling</td>
<td>Reservoir FBO</td>
<td>Reservoir FBO</td>
<td>Capacity development</td>
<td>Capacity development</td>
</tr>
</tbody>
</table>

PSD HMT Focus http://hmt.noaa.gov/
Sea to Summit to Sea
Integrated Monitoring, Analysis, and Prediction System

• Sea
  ▪ Offshore storm detection and tracking
  ▪ Numerical weather prediction models

• To Summit
  ▪ Gap-filling radars
  ▪ Rain, weather and soil moisture observations
  ▪ Numerical weather prediction models

• To Sea
  ▪ Stream flow observations
  ▪ Hydrological models – “Natural flows”
  ▪ Water management – “Managed flows”
San Francisco Bay Area R2O Projects

- **Russian River Basin**
  - Pilot for ESRL PSD HMT
  - Pilot for Integrated Water Resources Science and Services (IWRSS)
  - Pilot for National Integrated Drought Information System
  - Pilot for NOAA Habitat Blueprint Habitat Focus Area

- **SF Bay Advanced Quantitative Precipitation Information (AQPI) System**

- **SF Bay Integrated Hydrologic and Shoreline Flood Model**
Sea to Summit to Sea Integrated Monitoring, Analysis, and Prediction System

- AR Detection & Tracking
- Bias Adjusted Radar
- High-Res Numerical Weather Prediction Model
- Distributed Hydrologic Model
- Reservoir Operations Model
- USGS Cosmos Bay Model
- Integrated Water Management Model

AQPI-Basic C-band radar
- 4-6 hr lead time for off-shore precipitation
Enhance Flash Flood Warning Services With Distributed Hydrologic Model

• **Purpose:**
  - Account for spatial distribution of rain, topography, soils, land use and runoff
  - Tool to assess QPE/QPF products
  - Prototype for flash flood forecasting at ungauged sites

• **Research Distributed Hydrologic Model (RDHM):**
  - Developed by NWS-OHD for nation-wide deployment
  - 2-D using HRAP grid (~4.1 km side; also ~1 km)
  - Gridded precipitation and surface temperature (6-hr, 1-hr time steps)
  - Soil moisture linked to observations

• **Implemented in CHPS-FEWS:**
  - Prototype real-time operations
  - Links to real-time precipitation fields
  - Web display of animations
Reduce Flood Damages With Increased Lead Time

- Flood damage frequency relation
- Expected annual damage reductions with 12 hr lead time
  - Household contents value
  - 5% - 10% gross estimate
    - $240M per year
  - AQPI 1% - 2% incremental estimate
    - $62M per year

### Table: County-wise Flood Damage Estimates

<table>
<thead>
<tr>
<th>County</th>
<th>Structures in 100-yr Floodplain</th>
<th>Structures in 500-yr Floodplain</th>
<th>Exp. Annual Contents Damages [SM/yr]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alameda</td>
<td>10,100</td>
<td>38,500</td>
<td>$11.5</td>
</tr>
<tr>
<td>Contra Costa</td>
<td>15,300</td>
<td>25,300</td>
<td>$11.7</td>
</tr>
<tr>
<td>Marin</td>
<td>13,300</td>
<td>22,100</td>
<td>$10.2</td>
</tr>
<tr>
<td>Napa</td>
<td>4,900</td>
<td>6,500</td>
<td>$3.5</td>
</tr>
<tr>
<td>San Francisco</td>
<td>0</td>
<td>0</td>
<td>$0.0</td>
</tr>
<tr>
<td>San Mateo</td>
<td>30,300</td>
<td>44,700</td>
<td>$22.2</td>
</tr>
<tr>
<td>Santa Clara</td>
<td>37,100</td>
<td>201,600</td>
<td>$52.9</td>
</tr>
<tr>
<td>Solano</td>
<td>7,200</td>
<td>23,100</td>
<td>$7.5</td>
</tr>
<tr>
<td>Sonoma</td>
<td>7,900</td>
<td>11,600</td>
<td>$5.8</td>
</tr>
<tr>
<td>Total</td>
<td>126,100</td>
<td>373,400</td>
<td>$125.3</td>
</tr>
</tbody>
</table>

*Assuming contents at $50K per structure

Ref: CaDWR 2013: California’s Flood Future: Attachment D - Summary of Exposure and Infrastructure Inventory by County
Enhance Water Supply With Reservoir Forecast-based Operations (FBO)

- Fixed rule curve operations lose water by ignoring forecasts
- FldOps simulation model
  - Rule curves relaxed for a) flood pre-release if large rain forecast, and b) flood zone capture and hold if no rain forecast
  - 10-day inflow volume look ahead
- Overall increase in storage levels
  - ~ 10 KAF/yr potential additional capture
  - Increase release flows to later in Spring and Summer
  - @$1K/AF get $10M/yr benefit
Reduce Combined Sewer Discharges With Advanced Precipitation Information

- CASA, C-band, rain gauge network scalable to regional requirements
- Hi-res QPE, nowcasting and QPF (HRRR)
- Compatible with storm water models across region
- SFPUC interested to optimize combined sewer tank operation
- Integrated SF Bay storm inundation forecast
- Regional partners – shared benefits and costs –
  - CA DWR, SF Bay Counties
  - USGS, CNRFC, NOS
Enhance Endangered Fisheries Habitat With Coupled Water Management Modeling

- Gridded precipitation forecasts coupled to gridded hydro model (GHM)
- GHM generates gridded streamflow
- GHM coupled to water management model (WMM)
- Frost forecast model (FFM) used to generate vineyard frost protection water demands
- WMM evaluates pond storage to sustain fish flows
AQPI BENEFITS SUMMARY

• Overall
  - Total Wx Benefits ($240M/yr; $34/person)
  - Incremental AQPI Benefits ($62M/yr; $9/person)

• By Category
  - Flood Mitigation (61%)
  - Water Supply (23%)
  - Ecosystem Services (8%)
  - Transportation (8% (Ports 6%))

• By County
  - Santa Clara (Flood Mitigation)
  - Sonoma (Water Supply)

• Benefit/Cost Estimates
  - Best Estimate – 5:1
  - Optimistic – 13:1
  - Pessimistic - 2:1
Thanks

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