2017 INFEWS Kickoff Meeting Summary

The first full team INFEWS meeting was held over 1.5 days in Prosser, WA on 20-21 April 2017[1]. The main goals of the workshop were to 1) strengthen new and existing team member relationships, 2) discuss the broader integrative goals and outcomes of the project, and 3) lay a foundation for developing a Resilience Calculator framework. The major workshop activities and their outcomes are summarized below.

Overview of Project Aims

Each Aim leader gave a short overview of the tasks they are focusing on, and how the Aim fits into the larger project framework. *Aim 1* (S. Katz) discussed progress towards a conceptual FEW framework, logic model and first draft of a peer-reviewed manuscript. *Aim 2* (J. Adam) provided an overview of the model integration endeavors and progress. *Aim 3* (J. Boll) reported out on the suggested FEW innovations, gave a brief overview of two potential case studies on which to test initial iterations of the FEW Calculator and presented some initial work done by M. Luri on using MAR modeling to quantify resilience. *Aim 4a* (S. Hampton) discussed the importance of developing a meaningful definition of "resilience" for the CRB and plans for workshops to develop these definitions. *Aim 4b* (C. Kruger) provided an overview of how stakeholders will engage in the project.

Integrated Project Outcomes

Team members were asked to think about what they envisioned to be the best integrative outcome at the end of the project and work to combine or merge these ideas into a unified outcome with a prospective newspaper or journal article title. Three groups reported out these ideas as follows:

***Group 1**:* "Demand response kills two birds with one stone: gives more water for Columbia River Treaty (CRT) and helps survive drought" Improved conservation measures and new technology (e.g., smart meters, new irrigation technology) reduce demand during peak periods, which frees up water resources for other uses. Team members envisioned these resources becoming available to rebalance environmental and human needs in the CRT such that the Basin becomes more resilient to drought.

Group 2: "Columbia River Basin Project achieves sentience (or resilience)" The integrated product here focuses on markets to measure types and limits of adaptation and resilience in the Basin, and this information is used to inform regulators and other decision makers influencing the market on how to manage FEW resources. Participants commented that it also forces the question of "Do researchers have accountability or responsibility for the actions they take?"

Group 3: "Doing more with less: Reshuffling storage to the right time and place to meet demands and protect resource value". Storage plays a valuable role in FEW systems by reducing variability in resource availability and timing. Understanding where storages could be used more efficiently could help improve resilience across the CRB. In identifying where storage could be improved, researchers would also discover those fundamental or generalized resilience metrics that could be used in other systems.

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[1] A complete list of attendees can be found in Appendix A.

Case Study Group Discussions

Two case studies, the Yakima Basin and the Columbia River Treaty, were identified by Aim 3 as potentially useful locations to test the application of the FEW Calculator. Participants broke into small groups to discuss 1) where potential friction points exist between FEW resources 2) what innovations may increase resilience at each site 3) what metrics would be needed to measure changes in resilience and 4) whether these metrics or innovations are modelable. Group discussion focused primarily on the first two discussion points, a summary of which is given below:

Friction Points: where do tensions, inefficiencies or opportunities for improvement exist between F,E, and W management? All groups identified different "pockets" of friction points, indicating that FEW friction may not be a uniform problem, and may exist at different spatial and geographical scales. In general, groups found that both case studies struggle with competing uses for FEW resources that stem from existing mechanisms for allocating water and land resources and other exogenous factors (e.g. import/export/migration in agriculture). They also experience significant social friction as stakeholders struggle to balance these competing uses.

Two additional concepts were mentioned in this session: 1) that there are explicit friction points tied to the regulatory and management environments that perpetuate a complex and silo-ed approach to FEW management (a.k.a. "institutional complexity") and 2) to keep in mind that risk perceptions are skewed from existing climate variability- models must be able to incorporate historical trends (vs. assume a system reset each year) to really understand future impacts.

Yakima River Basin:

- The pro-rationing system of water rights & water law places inflexible bounds on how FEW resources are managed in the basin.
- There is substantial nitrate contamination in the basin from dairy farms, but strategies for cleaning up contaminants and sources of contamination are currently limited by technological and institutional (e.g. CAFO waste = toxic waste, cheap hydropower makes waste-to-energy recovery too expensive) barriers.
- Energy production at Chandler Dam requires a hydraulic pump, which reduces the amount of water available for instream flows.
- Increasing scarcity in the basin forced stakeholders work together to come to a basin-wide solution, ultimately reducing the amount of confrontation experienced between different groups. This highlights the importance of incorporating social frictions too (e.g. what is the value of peace in the valley?)
- Basin supports high-value crops, meaning biofuels would never be considered here as they're too low value. Artificially inflating the price of biofuel crops would inflate prices of other low value crops (refer to work by J. Yoder).
- Fish support was driving motivation for YBIP, but they are "unsupportable"
- Several groups found that there were strong friction points between food and water, but had trouble identifying connections to energy.
- On-farm labor: if decreased through technological innovation, could impact the greater social fabric of the CRB. Agriculture is the biggest employer (mostly in food processing and packing), and if eliminated (labor currently makes up 50-60% of costs) could devastate communities.

Columbia River Treaty:

- Current reservoir management strategies create issues that impact food production (e.g. interruptible water rights) and environmental health (e.g., instream flows, methane emissions, fish health/habitat). Note here that the treaty doesn't address diversions from the river (e.g., if Canada decided to allow for major diversions, that would be a problem for the USA).
- Indirect impacts of treaty changes- changing water rights or other policy can potentially not only affect growers (negatively), but can have ripple effects for the larger community (i.e., negative impacts for growers means negative impacts for processors, working communities, etc.)
- The low energy costs associated with hydropower create a strong disincentive to develop other innovations in the energy sector, whether technological (e.g. energy-to-waste recovery techniques) or institutional (shifting load balances).
- As the SW-GW connection becomes better understood in the CRB, there's potential that conjunctive management of these two resources will need to be explicitly addressed in the treaty.
- The fact that the Treaty is up for renegotiation introduces much potential for social friction. There are a large number of stakeholders with different goals providing input. Changes to either the US or Canada's fundamental role in the treaty (power production vs. flood storage) could also have wide-ranging ramifications

Innovations: what types of F, E or W innovations, whether technological or institutional, could be used to improve resilience in the case study basins considered? Innovations varied widely across discussion groups, but each recognized the importance of assessing not only how these innovations impact FEW availability, but wider ecological, economic and social environments as well. All groups recognized the difficulty and importance of developing a way to simulate innovations in institutional changes in a meaningful way (perhaps as "cost of innovation", or if there was a "FEWPA"- FEW Protection Act).

Yakima River Basin:

- Water markets, water trading and computer-based water transactions would be valuable for improving water for energy and water for agricultural efficiency.
- Greenhouses (small-scale, low technology) and new greenhouse technology (large-scale/high value commodity) could be useful if implemented strategically throughout the basin.
- Changing current water law to assign rights based on consumptive use (vs. volume withdrawn) may create a very different FEW landscape. Remote sensing could help measure this. Could explore a scenario where Odessa dries up and GW rights get new SW rights (junior or senior to existing rights?)
- Introducing dry year options contracts and on-farm small scale water storage (e.g. Roza) could be local-scale solutions to broader FEW problems
- Restructuring incentives to encourage bioenergy recovery could solve water quality issues while providing a new source of renewable energy.
- Increase adoption of low water user systems, precision systems, etc.
- Manage for short- and long-term business viability through markets and trading.

Columbia River Treaty:

- Managing energy demand response and improving incentives for making energy transmission more efficient. What's the risk of increasing tariffs?
- Utilizing conjunctive management (surface and groundwater) to increase effective storage throughout the basin- remote sensing, smart metering, etc.
- Exploring traditional and non-traditional distributed energy systems, whether it's micro-hydro, pumped hydro, anaerobic digestion, etc.
- Exploring distributed flood/water storage management strategies, including using flood plains for increasing water storage (e.g., levee setbacks), and reassessing flood targets at the major dams (e.g. The Dalles). Also explore improvements to existing water conveyance systems.
- Multiple devices/technologies were suggested, including salmon cannons, lake bottom outlets for regulating water temperature and fish passage, off-shore wind turbines for alternate energy production, and smart meters and smart systems for fine-scale management over large areas.
- Social engineering to change consumer preferences- innovations that shift demand?

Metrics: what metrics would be needed to measure the impact of FEW innovations on case study basin (or CRB) resilience? Many groups only superficially discussed how to develop metrics to measure FEW resilience. However, groups agreed that quantifying social resilience will be a major hurdle, as will evaluating the costs of innovations. The following summarizes those identified in group report outs as being potentially valuable:

- *Efficiency metrics,* are not a useful measure of resilience. Rather, things like discrete thresholds, derivative analyses of outputs, or qualitative outputs may be better.
- *Resource stocks and flows*, including specific metrics like virtual water and energy flows, water residence time, per capita storage, and supply-to-demand ratios
- *Price/Value,* especially around land use, and crop and energy production and distribution and how they shape consumer demands
- *Reliability metrics*, especially those that can assess the amount/frequency of failures to meet energy or water demands or instream flows
- *Social metrics*, including those that can capture changes in stakeholder/manager faith, confidence, reputation, and accountability
- *Benefit/use,* there was a specific call to evaluate whether defining metrics that evaluate benefit or use are more useful for measuring resilience than those that evaluate a specific quantity, volume or flux.
- *Social scaling,* was mentioned less as a metric but rather as a way to potentially scale physical metrics to reflect their impacts on society (e.g., a FEW scenario that significantly improves physical resilience, but does so at the cost of social benefit, is ranked below a similar scenario that have as high of a social cost)
- *Timing,* need to identify a way to capture the time coincidence of meeting demands- that transparent line for optimal supply and solid line for meeting timing- maybe as a phase angle difference between S & D. How "out-of-phase" is supply and demand?
- *Units,* mean/std dev could give a standard index. Need to understand how we separate the flower chart from our outputs from our derivatives (maybe build off Rushi's work?)

Unconference Discussions

The closing workshop activity was designed to give participants time to discuss either new ideas or topics that emerged during the course of the meeting, but were never the focus of conversation, or to spend more time discussing those difficult-to-address ideas that benefit from group input. The following topics were the focus of this activity and notes from each group are included below:

What is INFEWS? (Katz, Goldsby, Luri)

- What is getting traded? How do we measure it?
  - Units of measurement considered- $, # species extinct, evenness, diversity of balance
  - Utils- subjective values, a posteriori
  - Non-parametric MAR modeling- could get at the number of needs satisfied. This could take care of the unit/metric problem (-1.0 = deficit, 0 = none, 1.0 = all, >1.0 = surplus)
  - *More detail (visual) on this idea in the Notes folder for this meeting*

INFEWS Model Integration (Liu, Zhao, Mills)

1: Understand data needs and structure (spatial and temporal resolutions etc.) of various models:

- VIC-CropSyst-Mozart-WM: focused on water-food system (energy as well if reservoir storage being converted to hydro-power), simulates water resources and crop yields (water and food storage) under various scenarios (climate, management, etc.); running at 6km-6km resolution and hourly to daily time step;
- Energy optimization model: hydro-power generation; optimize energy generation depending on the energy demand (from EAGERS), distance (i.e. the distribution of battery storage and the structure of electrical grid), and reservoir water storage. The reservoir water storage could be derived from land-surface model (VIC-CropSyst-Mozart-WM); possibly use remote sensing or VIC simulations results (together with EAGER) to estimate the energy demand from cooling/heating buildings.
- System Dynamic model: not a spatial-distributed model (but may have spatial information); the time scale is flexible; various driving forces and sectors could be considered.

2: Integration approach:

- Off-line simulation- information flow between different models; impossible (or no need) for tight-coupling (i.e. running as one program).

3: Aggregation in different temporal and spatial scales:

- Daily-hourly; spatial to none-spatial aggregation; system dynamic might be treated as a high-level synthesis from grid-level land surface and energy generation/demand model. SDM can also contribute to the teleconnections between each regions in terms of food, water, and energy storage.

Whose Resilience (Guzman, Cosens, Padowski, Givens, Yorgey, Ames)

This group discussed how to better incorporate social benefits and risks into the INFEWS project. Specifically, participants brainstormed about the following:

- What type of metrics will be important? How will we identify specific metrics, where data would come from, and at what scale should we be assessing equity?
    - There may be a mutual benefit to working with Aim 1 folks who want to develop a rank order non-parametric MAR model. This type of model could help decide measures of resilience and reactance – what are we resilient towards that isn't a continuous variable (but may be a scaled or binary variable).
- What do we mean by resilience in a human system, and how does that overlap with physical resilience? This is very important, as "resilience" may very well not be the goal of a community (e.g. making a "poor" community resilient to becoming "rich")
- Barb has done a lot of work looking at the range of governance adaptations or failures that might occur under climate change – from drought to floods- and might be a useful starting place for building additional metrics.
- Case comparisons could be useful for studying how communities share burdens and mitigate vulnerability to increase "resilience". For instance, the recent adjudication in E Snake River Plain saw severe economic consequences, how does this differ from the processes and outcomes that developed in the Yakima basin?

Big Shocks (Richey, Hampton, Kruger, Stockle, Casola)

The goal of this group was to brainstorm a diversity of big possible shocks to the Columbia River basin that could have impacts on the food-energy- water systems of the region. The suggested shocks fell into two main categories: 1) instantaneous perturbations and 2) long-term shifts. We crossed perturbations that fell under a wide range of categories including physical, political, social, and technological. There was some discussion about how different shifts might filter through and impact the system but largely based on conjecture! Ultimately, this discussion lead us to task the question, "How resilient are we to disaster versus incremental/long term change?" While most disaster management planning is set up to mitigate negative impacts of disasters like floods and earthquakes, it is less clear that we have plans in place to anticipate and mitigate long-term perturbations. Examples discussed[2] included:

- A giant earthquake in Seattle
- Nuclear option by North Korea to take out or severely impair South Korea
- Global shifts toward increased beef consumption
- Tri-Cities becomes the new California
- Disruption of Phosphorous import
- Eco-terrorism takes out Grand Coulee
- Energy innovations to avoid using hydropower
- California as a wildcard in the energy system
- The grid goes down
- Canada emerges as an agricultural player and increases Columbia River diversions for irrigation
- Socialist takeover of land and water rights
- Government structure changes social welfare issues to consolidate power privately
- Federal support for ag changes
- Population shift to Eastern Washington, including corporations moving east

[2] For more information on the examples listed below, see Kick-off Meeting Notes on the Google Drive.

Appendix A. List of Kick-off Meeting Participants

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