Modeling and the Continuum between Research and Application

Rusty Holleman, PhD

2023 CWEMF Annual Meeting

UC DAVIS
CENTER FOR WATERSHED SCIENCES

RMA RESOURCE MANAGEMENT ASSOCIATES
WATER RESOURCES ENGINEERING

Who are you?

- Hydrodynamic modeler
  - 3D applications in the SF Estuary
  - Hydrodynamics and some water quality modeling
  - Model development
- UC Davis Center for Watershed Sciences
- Resource Management Associates
  - Projects for various agencies, HEC/Army Corps
- Previously at San Francisco Estuary Institute
  - Hydrodynamics, biogeochemical modeling

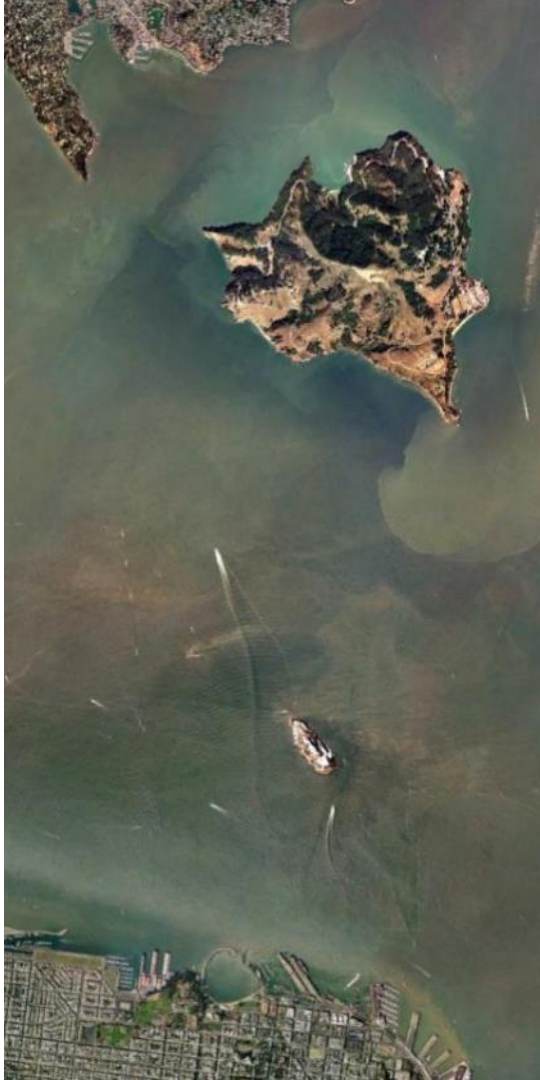
If I'm being honest…

…I've only recently looked closely at the Modeling Protocols.

Topics

- Research vs management, planning applications
- Academic setting vs consulting, agency setting
- How do the modeling protocols apply?

[sweeping generalizations lie ahead]



Research projects

- Grants – unilateral study design, proposal
- Less stakeholder involvement – veers towards “technocratic exercise”
- Peer-review is weak at the level of model calibration and evaluation.
- Scrutiny focused on theoretical advancement, novel methods, novel findings.
- Multi-year timeframe
- Sometimes the focus is on the modeling framework (e.g. numerics). Application reduced to a test case

Academic setting

- May lean heavily on graduate students
  - More tool-agnostic, open to novel and/or unproven codes, methods
  - Institutional knowledge challenging to maintain
- Modeling is a “*craft”*, but modeling “*artisans*” are scarce in academia
- Audience is other academics and success is measured by journal publications and grants
- Education and experience for students is part of the mandate

How does this relate to the Modeling Protocols?

Through the lens of the three checklists in the protocols

1. Initial Appraisal Prior to Study

Checklist 1. Model Study Initial Appraisal Prior to Study Inception

Item	Description	Response
1	Is the problem or question to be addressed well defined?	Yes/No
2	Do we know how the model results will be used and who will use the results?	Yes/No
3	Is the model to be used specified?	Yes/No
4	Has a conceptual framework been developed?	Yes/No
5	Have the criteria for selecting the model been defined?	Yes/No
6	Is an existing model going to be modified?	Yes/No
7	Is a new model to be developed?	Yes/No
8	Are the time frames known for initial model development, calibration, testing, and review?	Yes/No
9	Are data associated with intended model inputs available?	Yes/No
10	Are data associated with intended model outputs available (to support model calibration)?	Yes/No
11	Are time frames of the input and output data known and consistent with one another?	Yes/No
12	Are the errors in data measurements known?	Yes/No
13	Is the level of error in the expected results known?	Yes/No
14	Are the model stakeholders known?	Yes/No
15	Will stakeholders be part of the modeling process?	Yes/No
16	Have users of the model output met together?	Yes/No

2. Post-completion Appraisal

Checklist 2. Model Study Post-Completion Appraisal

Item	Description	Response (Numeric Score or narrative)
1	Is the model a new formulation or the application of an existing code? If a new formulation, what has been done to test and verify the code?	
2	Has a conceptual framework been developed for this effort and has it been updated following completion?	
3	Are observed data used in the modeling exercise (input and output data) documented and available for review?	
4	Has the calibration approach been described?	
5	Has the model performance following calibration been adequately evaluated using test data?	
6	Has the sensitivity of major variables been evaluated?	
7	Has model output uncertainty been evaluated?	
8	Were any novel approaches used to evaluate the sensitivity and uncertainty of the model response to inputs?	
9	Were the model results compared and contrasted with other models (if available)?	
10	Has documentation of the model study been prepared?	
11	Was a peer review performed and responded to?	
12	What were the stakeholder's reactions to the model results?	
13	Does the model study documentation adequately explain the approach, assumptions, and findings? Are the model summary documents easily understandable by a variety of audiences?	

3. Model Life-Cycle Evaluation

Checklist 3. Model Framework Life Cycle Evaluation

Item	Description	Narrative Response
1	Are all source codes and supporting files stored in a single location and archived in a manner that enables future access?	
2	Are the source codes documented, even if this documentation is not in the public domain?	
3	Is the model development dependent on a single individual? What is the long-term transition plan for the expertise in this model?	
4	Is the model framework applied by a community or by a single team? Is there a mechanism to share knowledge about the model application over time, such as a virtual community, trainings, etc.?	
5	Is there a defined plan for making updates to the model framework?	
6	For a public-domain model framework, is there a funding mechanism to support staff that would work on the model?	
7	For a proprietary model framework, what is the mechanism to support the code development over the long-term?	

1. Initial Appraisal Prior to Study

A good guide for writing grant proposals with substantial modeling components.

To the extent that proposals are developed unilaterally, important to anticipate questions.

	Description
2	How will model results be used?
4	Is there a conceptual model?
7	Is a new model to be developed?

2: Post-Completion Appraisal

Guide for writing the manuscript

(and project reports as in any other setting)

Peer review ubiquitous, but tends to focus on analysis and model setup, and weak on model evaluation.

MP guidance can improve writing and reviewing journal articles.

	Description
1	Has any new model code been tested/verified?
3	Are observed data documented and available?
4	Has the calibration approach been described?
11	Has the work been peer-reviewed?

3. Model Framework Life-cycle

Greatest weakness in academic settings.

Funding is by project, with little incentive or real requirement to build in longevity.

Yet this information is invaluable to new modelers.

	Description
1	Are source codes and supporting files archived?
2	Are source codes documented?
5	Is a plan defined for updating the model framework?

Institutional Knowledge and Model Durability

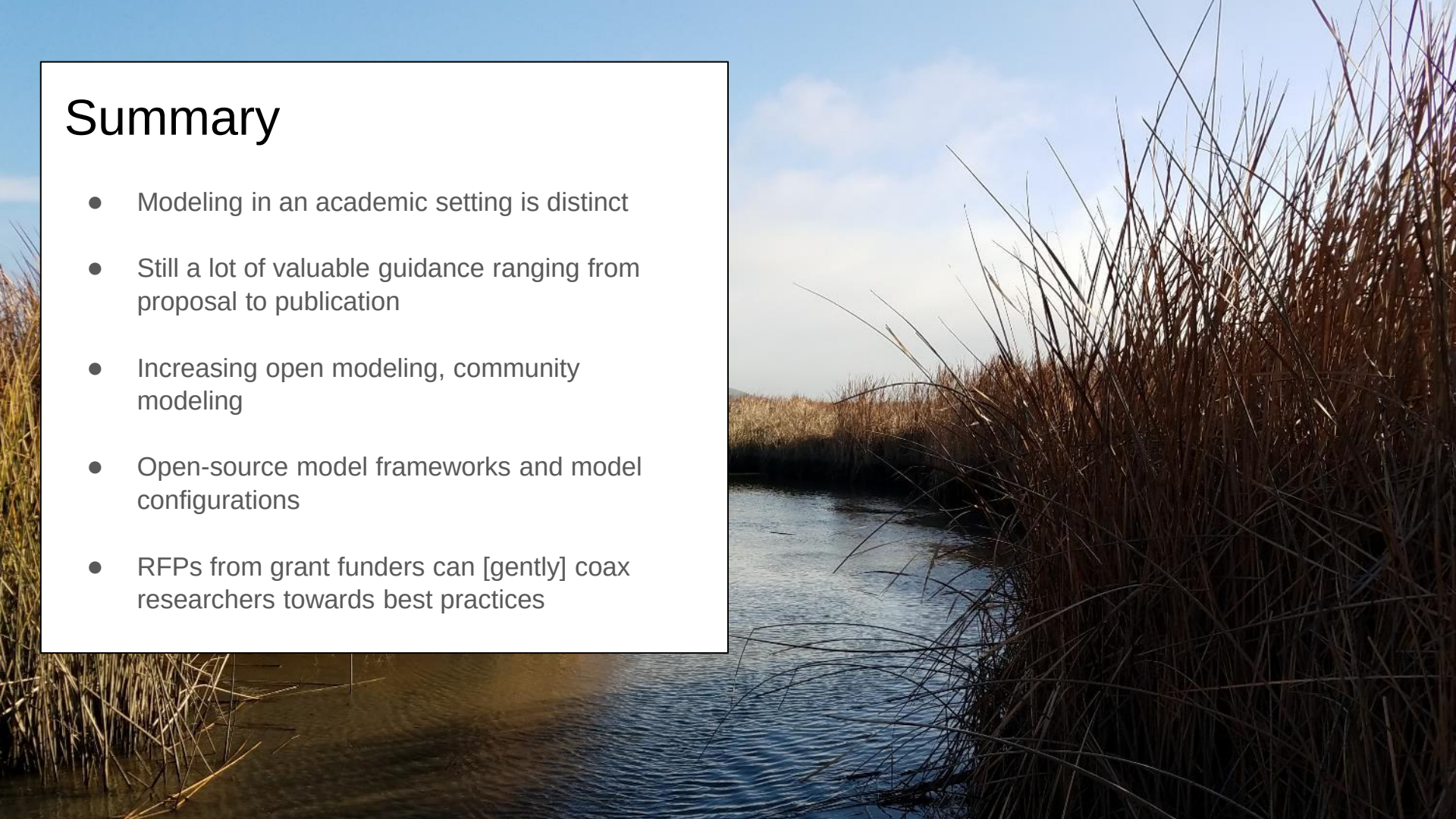
Hard to maintain institutional knowledge …
… Yet that is exactly what is needed to guide graduate students.

Some disciplines have lab managers or staff - a role that CWS researchers have played in the past.

A partial answer

- Put modeling work out in the open as much as possible.
- Don’t wait for community modeling – you can be an “open modeler” today
- Github, other publicly visible locations
- **Messy is better than never!**

- To some extent funding agencies and stakeholders can push for open modeling
- Ultimately rests with model practitioners to make it work.



Summary

- Modeling in an academic setting is distinct
- Still a lot of valuable guidance ranging from proposal to publication
- Increasing open modeling, community modeling
- Open-source model frameworks and model configurations
- RFPs from grant funders can [gently] coax researchers towards best practices