**Rivers As Social-Ecological-Technological Systems – Lesson Content**

The overall lesson format has two main parts.

The first requires the instructor to organize river specific content within the SETS domains and compare it against information students have independently assembled via large group discussion and filling out the first part of the data sheet.

The second requires students to analyze and synthesize this information to address a river issue of their particular choosing, in smaller groups if necessary, using the second part of the data sheet and system and stakeholder analysis exercise.

Part 1: This lesson is designed to have content tailored to the specific river in question. The goal is to use the context above to provide a framework for an instructor to organize information pertinent to the river being studied in the field. Ideally, these concepts are shared with students at the beginning of an intensive field experience (e.g. a source to sea river journey), and then deployed at the end, to integrate different types of knowledge and data within a collaborative problem solving environment. Instructors can add content related to governance of the river in relation to other field studies, along with additional information on the social history and present social relationships between people living throughout the river basin and the river itself.

To aid in this goal, several key categories of content should be assembled for a specific river in question. These can be assembled ahead of time, and organized in the following categories using the first part of the data sheet

Social Dimensions of Rivers:

* 1. Lived Experiences of rivers (beginning to integrate world views/identities, capacities/affordances)
     1. What direct uses or relationships do people have with this river? (desk based) Information on uses and relationships can be obtained ahead of time by web searches for recreational associations, angling associations, commercial fishing associations, etc… or in collaboration with a river steward or stakeholder group. These can include fishing, hunting, swimming, boating, hiking in the vicinity of, picnicking, etc… these may also include how infrastructures are built to interact with the river (e.g. the prevalence of river towns, power generation, manufacturing, agriculture etc…).
        1. Discussion question: Which uses and relationships are more or less prevalent in the vicinity of the field site and in your broader experience of the river?
  2. Governance or the River (integrating governance, consensus/dissensus
     1. What pertinent laws, policies, and regulations influence society-river relationships? How might these affect the different uses and relationships you have observed? Are there any river specific governance bodies of the river in question (e.g. Watershed Organizations, Coordinating Committees, etc…).
        1. Discussion Question: Who of the river constituencies identified above are represented by these bodies? Which are not?
     2. Exercise: Media discourse analysis. Find one recent news article on a river issue, and identify the different points of view and points of tension in the article. Are the different stakeholders you identified represented?
  3. Knowledge systems: What are the available sources of data on river conditions and relationships (e.g. flows, water quality, fisheries, biodiversity, floods, discharges from industrial facilities or waste water treatment plants, irrigation withdrawals). (*This should be assembled by the instructor ahead of time using USGS flow and precipitation (or NOAA/NWS) data, National Water Quality Monitoring Portal Water Quality Data, local or regional catch data, biodiversity data from GBIF, flood plain extent from FEMA, local sources, or First Street Foundation, Toxic Release Inventory or NPDES information, irrigation district or riparian water rights permit information from local sources ).*
     1. Discussion Question: Are there other types of information that would be useful but are not readily available with the current knowledge system around the river?

Ecological Dimensions of the River

* 1. What is the hydro-climatological regime of the river?. Is the river primarily rain fed, snow fed, a combination? How seasonal is precipitation?
     1. Discussion Questions: What are the current flow conditions of the river? How do they compare against long term mean and median conditions? What factors are affecting flow? Can you observe indications of how current flow conditions compare against long term conditions (e.g. relation to bank cutting)
  2. Hydro-geomorphological conditions. What are the predominant geological and soil conditions within the river basin? What factors affect the overall course of the river and its hydro-geomorphology?
     1. Discussion question: What types of sediment transport can you observe in the vicinity of your field site?
  3. Ecological structure and function. What ecotypes does the river pass through and what are its primary ecological communities?
     1. Discussion question: How does your current field site fit within the broader ecological continuum of the river basin?

Technological Dimensions of the River

* + 1. What infrastructures are present in the basin that affect river conditions?
       1. Discussion question: what infrastructures are visible in your field site? What influence of infrastructures can you observe?
    2. What Technological representations of the river exist?
       1. Discussion question: For specific data collection regimes identified above in knowledge systems which social and ecological aspects of the river are well represented, which ones are not? What data exist on infrastructures and land use?
    3. Indirect technological interactions, what might they be?
       1. Discussion question: How are they known/represented if at all?

Part 2: Integrative group based systems conceptualization and problem-solution framing.

With the above information assembled you are ready to create an interdisciplinary problem-solution team. Choose a field setting where you can experience the river and multiple aspects of it are visible. Ideally this is a setting where you can synthesize other field lessons that students have been exposed to (e.g. a mixing zone of two tributaries, a tidal confluence, a setting where different uses of the river are visible, etc…).

Next, have students identify their disciplinary orientations by briefly describiuing their background and disciplinary position/interests. This should be tailored to the size of the group, and if the group is very large (more than 30 students) you will want to split the group in half by asking those who identify primarily as social scientists vs natural scientists to split into two groups, and then shuffle about half of each one of those groups into each other. If the class is less than 15 students one group will suffice for the next activity, otherwise you will want to consider making groups of no less than 5 students and no more than 15.

**Choosing a Problem-Solution focus**

Of the numerous problems that have been articulated, each group of students will have to collectively choose one through simple voting. This can be done by first listing all the different issues that have been identified by the collective, combining where appropriate, and then voting on which one they should address.

Once an issue has been identified have groups of students discuss using the data sheet:

What SETS domains influence the issue? Which ones have a direct influence on the issue? Which ones have an indirect influence? Which linkages do we have data for (from the knowledge systems analysis)? Which ones do we need more information? What social factors would need to be addressed to influence the issue? What are the environmental responses required to ‘solve’ the issue? What technologies/infrastructures would have to change to address the issue?

With the guiding questions above, students in groups will then utilize the provided data sheets and prompts to collaboratively draw a partial systems model accompanied by a short narrative describing:

1) an integrative causal understanding of the issue, SETS drivers, and a desired outcome on the issue

2) data gaps, if any, that must be addressed to improve causal linkages and monitor the effectiveness of interventions

3) proposed actions to address the issue, including a research to action agenda that may be required to address the gaps identified in 2.