# Structure for White Paper
# Sustainability Infusion Project

## Title of Module/Activity

The Food-Energy-Water-Nexus

## Course Name and Course Number

SCIL/AECN/ENVR/GEOG/NRES 109: *Water in Society* (see Forbes et al., 2018)

## Length of Module/Activity

The module is a 2-week, stand-alone unit of study using a computer-based modeling tool (HydroViz) grounded in authentic hydrologic data to engage in systems thinking about a contemporary socio-hydrological challenge.

## Primary Learning Outcomes:

Using HyrdoViz, students will be able to ….

1. Examine the geographical distribution of water and power plants in the United States and Nebraska.
2. Identify, compare, and contrast types and intensity of human use of water and energy resources in the United States and Nebraska
3. Analyze a socio-hydrological challenge involving water resource use in Nebraska
4. Generate a proposed solution to this socio-hydrological challenge in the state of Nebraska

## Resilience and/or Sustainability Connections

In the module, students engage with concepts related to both sustainability and resilience. In terms of ***sustainability***, students use HydroViz to first explore water resource use and energy generation. Then, they are tasked with using this information to problem-solve a real-world proposal by the Omaha Public Power District (OPPD) have 100% carbon-neutral energy generation by 2050. Students use HydroViz to propose a plan for OPPD with the smallest water footprint that reflects the carbon goals, thus contributing to *"effective, efficient, economic, equitable, and environmentally/ socially responsible use of resources to meet our needs that considers the long-term implications of our choices today on the future of Earth's life support systems and the implications that this use has on all stakeholders involved."* In terms of ***resilience***, the proposed plans reflect enhanced abilities to meet OPPD's energy generation needs in the face of drought, extreme weather events, and other environmental conditions associated with climate change that may negatively impact consistent water availability for energy generation.

## Identify One or More of the Key Sustainability Competencies Addressed

The new module directly promotes strategic competence and systems thinking. In terms of ***strategic competence***, students use a data-driven-computer based tool to analyze and propose a design solution to challenge grounded in the FEW-Nexus. A fundamental criteria of the problem-solving task is to propose a sustainable solution through evaluation of available information on both human and natural components

of socio-hydrologic systems. To process this information, students must engage in systems thinking, considering both components and processes of these coupled human-natural systems, including interactions, processes, feedbacks, and various stakeholders. The proposed solution to the real-world socio-hydrologic challenge should reflect the most feasible path forward that mitigates risk to both human enterprise and the natural environment.

## Instructional Strategies

The course is structured to include two whole-group class meetings and one smaller discussion group meeting each week. In whole-group class meetings, we employ a learning assistant model to support student interaction and provide real-time instructional support. Class meetings involve an array of learning structures, including large group discussions, small group discussions, group writing prompts, and sharing ideas and questions from small group to large group settings. As part of the module, students will use HydroViz and work with peers to analyze the FEW-Nexus in Nebraska, individually propose a solution to a real-world challenge, and communicate their observations, reasoning, and proposed solutions at various points during the 2-week module period. Active learning strategies comprising the instructional plan include think-pair-share, jigsaw groups, in-class collaborative discussions, among others.

## Assessment Strategy

The module assessment plan includes both formative and summative elements. First, formative assessment have been developed to address each of the four proposed learning outcomes. Second, a comprehensive student assignment, which is divided into two parts, will provide an overall summative assessment of student learning. Part I involves students' use of HydroViz to explore water availability, water use, and energy production in the United States and Nebraska. In Part II, they are tasked with formulating a carbon-neutral power generation plan for OPPD that has the lowest possible water footprint in alignment with contemporary, real-world FEW-Nexus challenges and policy in the state of Nebraska. Student responses to Part I will be scored for accuracy and correctness. Students' responses to Part II will be scored using a rubric for model-based reasoning about socio-hydrological issues developed and validated through prior research in the course (e.g., Lally & Forbes, 2019; Petitt & Forbes, 2019, Sabel et al., 2019).

| Objectives | Formative Assessments | Summative Assessments |
|---|---|---|
| Using HyrdoViz, students will be able to …. | | |
| 1. Examine the geographical distribution of water and power plants in the United States and Nebraska. | FA #1 | Student Assignment Part I |
| 2. Identify, compare, and contrast types and intensity of human use of water and energy resources in the United States and Nebraska | FA #2 | |
| 3. Analyze a socio-hydrological challenge involving water resource use in Nebraska | FA #3 | Student Assignment Part II |
| 4. Generate a proposed solution to this socio-hydrological challenge in the state of Nebraska | FA #4 | |

References

Forbes, C.T., Brozovic, N., Franz, T., Lally, D., & Petitt, D. (2018). Water in Society: An interdisciplinary course to support undergraduate students' water literacy. *Journal of College Science Teaching, 48*(1), 36-42.

Lally, D. & Forbes, C.T. (2019). Modeling water systems in an introductory undergraduate course: Students' use and evaluation of data-driven, computer-based models. *International Journal of Science Education, 41*(14), 1999-2023.

Petitt, D.N. & Forbes, C.T. (2019). Values use of undergraduate students in socio-hydrological reasoning: A comparative study. *Natural Sciences Education, 48*(1), 1-12.

Sabel, J.L., Vo, T., Alred, A., Dauer, J.M., & Forbes, C.T. (2017). Undergraduate students' scientifically-informed decision-making about socio-hydrological issues. *Journal of College Science Teaching, 46*(6), 64-72.