Can We Have Healthy Living Environments in Mining-Impacted River Basins?

The Case of the Coeur d'Alene River Basin, Idaho, USA

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Summary
This case familiarizes students with toxic metal contamination, remediation and restoration options, and stakeholder perspectives across a complex social-ecological system (SES). The location of the case is the Coeur d'Alene River Basin in northern Idaho, USA. Metal mining occurred in the Basin starting in the 1880s. During this time, mine waste was released directly into creeks and rivers for decades. Due to flood events, contamination was dispersed over hundreds of acres of the expansive valley floor. As a result, a large portion of the Basin was designated a Superfund site in 1983. Today the site is the second largest Superfund site by land area with the largest residential population living within the Superfund site boundaries of any site in the US. The Superfund clean-up process has helped to mostly contain contamination from past mining within residential communities. The clean-up has been led by local, state, and federal partners. Unfortunately, contamination persists throughout the Basin. Yearly spring flooding means that popular beaches and wetland areas with the primary floodplains of the Coeur d'Alene River have high concentrations of toxic metals include Zinc, Cadmium, Arsenic, and Lead.

The case learning objectives are: (1) Describe the sources and deposition of toxic metal contamination, and how metal contamination affects people and the environment in the CdA Basin system. (2) Recognize and explain the federal, state, and local policy options for managing lead contamination. (3) Develop data analysis, synthesis of ideas, and critical thinking skills. (4) Develop written and oral presentation skills by drafting and presenting public comments about a proposed environmental remediation project. (5) Learn how to evaluate environmental issues from different perspectives. Activities include creating a map of lead levels along the river, conducting a rainbow assessment of stakeholders, engaging in a mock public hearing, and assessing risk messaging signage in the Basin.

The case is designed to be taught in six 75-minute class meetings to 200 or 300-level undergraduate students. Students will have already received instruction about fundamental concepts of SE synthesis. The public hearing activity could be adapted for other cases with ongoing restoration or remediation activities.

S-E Synthesis Learning Goals
Develop socio-cultural awareness: Ability to understand and appreciate the importance and difficulty of public participation in environmental regulation and communication.
Conduct preliminary integrative research: Use different types of data to make an argument about impacts of pollution and management actions on social and environmental system components.

Learning Objectives
1. Describe the sources and deposition of toxic metal contamination, and how metal contamination affects people and the environment in the CdA Basin system
2. Recognize and explain the federal, state, and local law and policy options for managing lead contamination
3. Develop data analysis, synthesis of ideas, and critical thinking skills
4. Develop written and oral presentation skills by drafting and presenting public comments about a proposed environmental remediation project.
5. Learn how to evaluate environmental issues from different perspectives (industry, environmental protection, economic development, public health, and environmental justice).

Introduction
At the core of many environmental issues are intertwined social and ecological processes that drive changes for both ecological systems and human communities at multiple scales. Historically, academic disciplines have struggled to understand the multiple causes of environmental problems; thus, interdisciplinary social-ecological approaches are increasingly being used to study linked processes. Studying social-ecological systems can provide important insights into complex dynamics operating across temporal and spatial scales. In the course associated with this case, we use case studies to learn about key concepts in social-ecological systems such as resilience, vulnerability, adaptation, slow and fast variables, feedbacks, ecosystem services, and complex adaptive systems.

The location of the case is the Coeur d'Alene River Basin in northern Idaho, USA. Metal mining occurred in the Basin starting in the 1880s. During this time, mine waste was released directly into creeks and rivers for decades. Due to flood events, contamination was dispersed over hundreds of acres of the expansive valley floor. As a result, a large portion of the Basin was designated a Superfund site in 1983. Today the site is the second largest Superfund site by land area with the largest residential population living within the Superfund site boundaries of any site in the US (Gustavson 2007). The Superfund clean-up process has helped to mostly contain contamination from past mining within residential communities. The clean-up has been led by local, state, and federal partners. Unfortunately, contamination persists throughout the Basin. Yearly spring flooding means that popular beaches and wetland areas with the primary floodplains of the Coeur d'Alene River have high concentrations of toxic metals include zinc, cadmium, arsenic, and lead.

Classroom management
See the Activity Packet and slide deck for directions on running the four case activities and associated lectures. The teaching notes and activities are integrated to demonstrate how the activities build on one another.

Assessment
Assessment tools are included in the activity packet. Each activity includes a corresponding worksheet. Contact the authors for answer keys to these activities.

Background
See the associated Slide Deck for more case study background and discussion questions. The references below also help to introduce the case.

References

1. EPA (2012). "Coeur d'Alene Basin Record of Decision Amendment Site Update."
2. Gustavson KE, Barnthouse LW, Brierley CL, Clark EH, Ward CH. (2007) Superfund and mining megasites. *Environmental Science and Technology*, **41**:2667–2672.
3. Metcalf, E.C., Mohr, J.J., Yung, L., Metcalf, P., Craig, D., 2015. The role of trust in restoration success: Public engagement and temporal and spatial scale in a complex social-ecological system. Restor. Ecol. 23, 315–324. https://doi.org/10.1111/rec.12188
4. Rosenwinkel, Hans. "Heavy Metal - An American Pollution Story." 2005. Available on Kanopy.
5. Witte, K., Meyer, Gary, & Martell, Dennis. (2001). Effective health risk messages: A step-by-step guide. Thousand Oaks, Calif.: SAGE.

Reading notes: References 1 and 2 important introductory reading on toxic metal contamination and the Superfund site [accompany Activity 1]. Film (Ref 4 above) is a good introduction to the stakeholders in the Basin [accompanies Activities 2 and 3]. Reference 3 describes a similar Superfund site, and discusses the importance of trust in environmental clean-up projects [accompanies Activities 2 and 3]. Reference 5 gives recommendations for health risk messaging [accompanies Activity 4].

Suggested modifications
Omitting any of the activities is possible if students read the background materials associated with the activities. The unit can be expanded by providing additional time for developing the public service announcement included in activity 4. Finally, while activity 1 describes how to complete the activity in ESRI ArcGIS Online, the activity could be completed through an alternative mapping program.

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