1. **Title**

   Socio-environmental synthesis of a water conflict – A teaching case study

2. **Author Information** and **Author's Note**

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   Please let me know if you use this case. I welcome any feedback/suggested modifications to this case.

3. **Summary**

   Agricultural drainage is an integral feature of the agricultural landscape in the Midwestern United States. Des Moines Water Works (DMWW), a public utility company providing drinking water for approximately 500,000 residents in Des Moines, the capital city of Iowa, and its surrounding areas, filed a federal lawsuit against 10 upstream drainage districts[1] in March 2015. The lawsuit claimed that the drainage districts were channeling high levels of nitrates into the Raccoon River, a source of drinking water for the downstream residents in Des Moines and its surrounding areas. The lawsuit contended that agricultural drainage tiles were disrupting the natural conditions that otherwise treat nitrates and keep them from entering downstream waterbodies. Damages and penalties were sought from the drainage districts for the costs incurred by the utility company in removing nitrates from drinking water. The lawsuit also sought to have farmers regulated under the federal Clean Water Act, as point source of pollution. The lawsuit was dismissed by a federal judge in March 2017.

   Keeping the DMWW lawsuit at the core, a classic case of water quality conflict involving upstream-downstream stakeholders, the following case study aims at enabling students understand the complexity and interconnectedness of the environmental and social components of water quality management. Using stakeholder analysis, creation of mental models, and role-play activity, students will develop an understanding of how a situation of conflict unfolds when water users face collective action problems. The case study also situates the Iowa water quality conflict within the broader context of the Gulf of Mexico dead zone. This case study is suitable for interdisciplinary programs where students are trained in both the natural and the social sciences. The case study is suitable for upper level undergraduate students with a class strength of 20-25 students.

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[1] Specifically, the lawsuit was filed against the county supervisors of three Iowa counties – Buena Vista, Calhoun and Sac, who act in the capacity of trustees of these drainage districts.

5. **S-E Synthesis Learning Goals**

The following S-E synthesis learning goals are addressed in this case –

S-E Synthesis Learning Goal 1: Understand the structure and behavior of socio-environmental systems.

1.1 Identify the environmental and social components of the system and their interactions.

Related activities:

Students will create a stakeholder typology and mental model identifying social and environmental drivers of water quality conflict in Iowa.

1.2 Identify feedbacks and explain the dynamics of an S-E system.

Related activity:

Students will create a stakeholder typology and mental model identifying social and environmental drivers of water quality conflict in Iowa. As part of this process, students will also identify the interconnectedness of the two components, including feedback loops. Overall, these activities will help students develop systems thinking of environmental issues.

1.3 Use tools and modeling approaches to understand dynamics of an S-E system.

Related activity:

Students will create a mental model that will help them understand the dynamics of an S-E system.

S-E Synthesis Learning Goal 2: Consider the importance of scale and context in addressing socio-environmental problems.

2.1 Understand that ecological and social processes often vary across differing contexts, including space, time, and conditions (e.g. economic or political).

Related activity:

Students will create a mental model wherein they will identify the ecological and social processes at the watershed scale (in Iowa) and the basin scale (Mississippi River Basin)

2.2 Understand that ecological and social processes interact across different scales.

Related activity:

Students will create a mental model wherein they will identify the ecological and social processes at the watershed scale (in Iowa) and the basin scale (Mississippi River Basin)

S-E Synthesis Learning Goal 3: Co-develop research questions and conceptual models in inter- or trans-disciplinary teams

3.3 Understand the value of different knowledge sources and ways of knowing

Related activity:

Students will participate in role play activity which will help them understand the value of different knowledge sources (diverse stakeholders' perspectives on the water quality conflict).

S-E Synthesis Learning Goal 4: Find, analyze, and synthesize existing data, ideas (e.g. frameworks or models), or methods

4.4 Use geospatial and visualization tools

Related activity:
Students will use the mental modeler software to aid visualization of the interconnectedness of an S-E system.

6. **Learning Objectives** (what should students know or be able to do as a result of this activity?)

   This case is designed to help students achieve the following learning outcomes:

   - Students will develop an understanding of how water quality conflict unfolds.
   - Students will be able to identify stakeholders in a S-E system and how their actions affect each other.
   - Students will develop an understanding of water quality management dynamics involving upstream-downstream stakeholders.
   - Students will be able to identify factors driving farmers' adoption of conservation practices and farmers' participation in conservation programs.
   - Students will be able to put themselves in the shoes of other stakeholders and find solutions to complex environmental issues.
   - Students will be able to think about environmental issues as S-E systems, i.e. develop/nurture systems thinking ability.

7. **Introduction**[2]

   Des Moines Water Works (DMWW), a public utility company providing drinking water for approximately 500,000 residents in Des Moines, the capital city of Iowa, and its surrounding areas, filed a federal lawsuit against 10 upstream drainage districts in March 2015. The lawsuit claimed that the drainage districts were channeling high levels of nitrates into the Raccoon River, a source of drinking water for the downstream residents in Des Moines and its surrounding areas. The lawsuit contended that agricultural drainage tiles were disrupting the natural conditions that otherwise treat nitrates and keep them from entering downstream waterbodies. Damages and penalties were sought from the drainage districts for the costs incurred by the utility company in removing nitrates from drinking water. The lawsuit also sought to have farmers regulated under the federal Clean Water Act, as point source of pollution. The lawsuit was dismissed by a federal judge in March 2017.

[2] Adapted from the National Center for Case Study Teaching in Science

While interviewing[3] Richard[4], a farmer in Iowa, he quipped, *"…. I'm trying to, piece by piece, let's get it* [the water] *cleaned up before Ames* [a downstream city] *gets on us!"* Richard was describing his efforts[5] to reduce nonpoint source pollution runoff from his farmland. As per scientific estimates, it will cost $1.2 billion annually over five decades for farmers like Richard to establish the conservation infrastructure needed to offset environmental impacts associated with Iowa's intensive farming (Iowa Drainage District Association, 2015b). Iowa is the leading producer of corn, soybean, egg, pork and beef in the country. Richard's quip was shortly followed by his recollection of the lawsuit filed by the Des Moines Water Works. He said, *"…You might want to shut your tape recorder off if you get me talking about that* [lawsuit]*…"* The palpable anger and frustration is a classic example of response from an upstream stakeholder on getting blamed by a downstream stakeholder for the quality of water downstream. Emphasizing the importance of everyone to cooperate in solving the collective action problem of managing water quality, Bryan, another farmer from Iowa, mentioned, *"…cooperation is better than lawsuits…because if you get sued-- I haven't heard too many farmers that have had anything good to say about* [the Des Moines Water Works lawsuit]. *But I think doing something for water quality is important. But by the same token, in this area, you got to have tile drainage in order to make the land productive. So then you got to decide, ""Well, is nitrate in the water worse than starving to death?""*

Keeping the DMWW lawsuit at the core, a classic case of water quality conflict involving upstream-downstream stakeholders, the following case study aims at enabling students understand the complexity and interconnectedness of the environmental and social components of water quality management. Using stakeholder analysis, creation of mental models, and role-play activity, students will develop an understanding of how a situation of conflict unfolds when water users face collective action problems. The case study also situates the Iowa water quality conflict within the broader context of the Gulf of Mexico dead zone. This case study is suitable for interdisciplinary programs where students are trained in both the natural and the social sciences. The case study is suitable for courses with about 20-25 student.

8. Classroom Management[6]

Classroom management summary: This topic is to be taught in three sessions, each of 75 minutes. The total amount of class time is 225 minutes, or 3 hours and 45 minutes.

[3] Throughout the case study, farmer quotes are from the interviews conducted by the author, except when noted otherwise.
[4] Any names used in the case study, including this one, unless stated along with their official designation, is fictional.
[5] Such efforts include, but are not limited to adoption of conservation practices such as cover crops, buffer strips, etc. These practices have benefits such as improved soil health, reduced nutrient runoff, etc.
[6] Adapted from the National Center for Case Study Teaching in Science

Class 1. Who are the stakeholders in the water conflict?

Pre-class activities:

1. Watch the following video:

1.1 Iowa's water quality lawsuit explained. The Des Moines Register. Duration: Approx. 1 minute. Available online at: https://www.desmoinesregister.com/videos/money/agriculture/2017/03/23/iowa's-water-quality-lawsuit-explained/83347402/

2. Complete the following readings:

2.1 Prokopy, L. S., Floress, K., Klotthor-Weinkauf, D., & Baumgart-Getz, A. (2008). Determinants of agricultural best management practice adoption: Evidence from the literature. *Journal of Soil and Water Conservation*, *63*(5), 300-311.

2.2 Reimer, A. P., & Prokopy, L. S. (2014). Farmer participation in US Farm Bill conservation programs. *Environmental management*, *53*(2), 318-332.

2.3 Brianne, P., & Donnelle, E. (2018). Key achievement or drop in bucket? What $282 million water quality bill means for Iowans. *The Des Moines Register*. Available online at: https://www.desmoinesregister.com/story/news/politics/2018/01/27/iowa-water-quality-what-282-million-bill-means-iowans/1068634001/

2.4 Reed, M. S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., ... & Stringer, L. C. (2009). Who's in and why? A typology of stakeholder analysis methods for natural resource management. *Journal of environmental management*, *90*(5), 1933-1949.

Class activities:

1. The class begins with a 5-minute introduction to the DMWW lawsuit. This is followed by 10 minutes lecture about barriers and motivations for farmers to adopt conservation practices and for farmers to participate in conservation programs. The key topics this lecture should cover are:

(1) What are conservation practices?
(2) What is voluntary adoption of conservation practices?
(3) Role of conservation programs in promoting voluntary adoption of conservation practices.
(4) Synthesis of factors motivating adoption of conservation practices and participation in conservation programs.
(5) Synthesis of factors hindering adoption of conservation practices and participation in conservation programs.
(6) Highlight the complexity of conservation decision making.

2. The lecture is followed by prompting students to ask questions in light of the assigned readings and the video they watched (1.1, 2.1, 2.2, & 2.3 from pre-class activity). A

discussion should ensue around the lawsuit and farmers' barriers and motivation to adopt conservation practices and participate in conservation practices/programs. The discussion should last for about 5-10 minutes.

3. The instructor will then briefly talk about stakeholder analysis and what it entails (2.4 from pre-class activity). Using the rainbow diagram in the article (Reed et al., 2009; Fig. 2; pp. 1938), the instructor will demonstrate to the students how it could be used for classifying stakeholders according to the degree they can affect or be affected by a problem. This activity should take about 15 minutes.

4. Students will then work in groups of 3-4, utilizing the rainbow diagram to classify stakeholders. This activity will take about 20 minutes and help students identify the relevant stakeholders in the water conflict. Students will then tape their rainbow diagram to the black/white board of the classroom.

5. In the last 15-20 minutes of the session, each group of students will be encouraged to provide constructive feedback on another group's rainbow diagram. A discussion should ensue, which could be facilitated by asking questions such as:

> 5.1 Were all stakeholder groups relevant to water conflict identified? Are there any missing stakeholders?
> 5.2 As per the typology used, were stakeholders placed correctly with respect to 'affecting', 'affecting and affected' and 'affected' categories?

Class 2. Socio-environmental synthesis of the water conflict

Pre-class activities:

1. Watch the following video:

Gulf of Mexico 'Dead Zone' Largest Ever Measured. National Centers for Coastal Ocean Science. Duration: Approx. 2 minutes. Available online at: https://cdn.coastalscience.noaa.gov/csvideo/GOMEX_Dead_Zone_update_2017-SM.mp4?_=1

2. Familiarize yourself with mental modeler software:

Both the students and the instructor should download the mental modeler software (available at http://www.mentalmodeler.org/) and familiarize themselves with it. There are several helpful tutorials about using mental modeler on this website (available at http://www.mentalmodeler.org/#resources). The instructor should be able to explain the basic features of the software to the students. Both the students and the instructor should bring laptop to the classroom.

Class activities:

1. The students will watch the following video: Ocean Frontiers - Iowa & the Gulf of Mexico. Duration: Approx. 20 minutes. Available online at: https://www.youtube.com/watch?v=wvz10thW1M4

2. The students will be encouraged to share their thoughts about the video, especially in the light of the water conflict discussed in the previous class. This activity will take about 5 minutes. The instructor can use the following question as a prompt to encourage discussion:

> 2.1 What do students think about Iowan farmers' efforts to tackle non-point source pollution runoff in the Gulf of Mexico?
> 2.2 What are the environmental and social drivers of dead zone in the Gulf of Mexico?

3. The instructor will then provide a 10 minute tutorial on how to use the mental modeler software. The instructor will also explain how the software can be used to visualize interactions between social and environmental drivers of water conflict/Gulf of Mexico dead zone. Overall, this activity will take 15 minutes.

4. Working in groups of 3-4, students will create a mental model wherein the goal would be to help them understand the interconnectedness of social and environmental drivers of the water conflict and the dead zone in the Gulf of Mexico. Overall, students will be able to understand the aforementioned environmental issues as a system. Specifically, they will develop an understanding of the importance of scale and context in addressing socio-environmental problems. This activity will take about 20 minutes.

5. The remainder of the class time will be used for discussion. 2 or 3 groups will be invited to share their mental model with the classroom. Each group will walk the class through their model, explaining the interconnectedness and feedback loops, if any, of the social and environmental components of their system.

Towards the end of the class, the instructor will announce that there will be a role-play activity in the class, and that students should come prepared. Specifically, students should be able to apply their knowledge from the stakeholder analysis (in class 1) and mental model (in class 2) to come to a mutually agreeable strategy (or not!) to deal with the water quality issue in Iowa.

Class 3. Working together in the wake of a water conflict

Pre-class activities: For the instructor

1. The instructor should be careful in ensuring that students themselves take a stand on the issue. The role description should neutral. For example, the farmers' role description should not state that they felt blamed for the issue. Students, in their assigned groups, should decide this for themselves.

2. Please also note, that the role play activity is limited to the core set of stakeholders described in the case study background. The goal is to provide students with enough overall background (from sessions 1 and 2), so that these broader discussions on water quality, both in Iowa and the Mississippi River Basin, emerge in the classroom. From a practical standpoint, the goal is to keep classroom activities manageable.

Class activities:

1. The instructor will set the background of the role-play by reading the following text to the class: *"You all, the 4 groups of stakeholders, have come together to this informal deliberation session one month after the lawsuit was dismissed. Your goal today is to have your assigned stakeholder group's voices heard, including your current position on the water quality issue in Iowa, and the actions you have taken to deal with the issue. Overall, the goal of this informal deliberation session is to agree on a common strategy to deal with the water quality issue in Iowa."*

2. The instructor will randomly assign every student to one of the four groups. Each group will have 4-5 students. The instructor will also remind the participants to be respectful of each other and allow every stakeholder group to freely voice their opinions. Class activities 1 and 2 should take about 5 minutes.

3. Once students have been assigned to their roles/stakeholder groups, the instructor will hand over role description (see below) to the respective groups. This activity will take about 20 minutes.

Stakeholder Role 1. FARMER: You are a farmer in the Raccoon River watershed. You consider yourself a conservation minded farmer who, over the past couple of decades, has adopted a suite of conservation practices, such as cover crops, no-till, grassed waterways, etc.

Work within your group to answer the following questions:
What is your current position on the water quality issue in Iowa?
What actions have you taken to deal with the issue?
In your opinion, what is mutually agreeable strategy to deal with the water quality issue in Iowa?

Stakeholder Role 2. DRAINAGE DISTRICT: You are the president of Iowa drainage district association (IDDA), which is the only organization in Iowa specifically representing drainage interests. Historically, IDDA was created so that the issues surrounding drainage could have a policy voice at the state level.

Work within your group to answer the following questions:
What is your current position on the water quality issue in Iowa?
What actions have you taken to deal with the issue?
In your opinion, what is mutually agreeable strategy to deal with the water quality issue in Iowa?

Stakeholder Role 3. WATER UTILITY: You are the CEO of the Des Moines Water Works, the utility company that filed the lawsuit. You provide drinking water to approximately 500,000 residents in Des Moines and its surrounding areas. With the lawsuit dismissed, you may have to continue to incur costs associated with removing nitrates from drinking water.

Work within your group to answer the following questions:
What is your current position on the water quality issue in Iowa?
What actions have you taken to deal with the issue?
In your opinion, what is mutually agreeable strategy to deal with the water quality issue in Iowa?

Stakeholder Role 4. CITY RESIDENT: You are a resident of Des Moines with two young kids. You have noticed an increase in your water bill. Belonging to a middle income household and having young kids, you are very concerned about both the economics and health impacts of water.

Work within your group to answer the following questions:
What is your current position on the water quality issue in Iowa?
What actions have you taken to deal with the issue?
In your opinion, what is mutually agreeable strategy to deal with the water quality issue in Iowa?

4. Each stakeholder group will then get 5 minutes to report their internal deliberations. The instructor will encourage each group to especially reflect upon disagreements, if any, within their group. The instructor will also encourage each group to describe how they arrived at their respective 'mutually agreeable strategy'. This activity will take about 20 minutes.

5. After every stakeholder group reports their deliberations, the instructor will encourage the class, as a whole, to discuss the questions below. This activity will take about 10 minutes.

> 5.1 What is a strategy that's agreeable to everyone part of the informal deliberation?
> 5.2 In coming up with a mutually agreeable strategy, how did, if at all, the group of four stakeholders account for stakeholders' interests not represented at the informal deliberation?
> 5.3 Will the mutually agreed upon strategy work if more stakeholders were invited to the table? If yes, then how. If no, then why not?

6. After the discussion, the students will watch the video: 'Common Ground, Common Water' (available at https://iwrrc.org/commongroundcommonwater/, click on the "View the video" link; also available on YouTube at https://youtu.be/qzrp2OfrfLk). This video is approximately 12 minutes long.

7. The remainder of the class will be used for discussion and to answer any question students may have.

9. **Assessment**

Formative assessments:

Class 1. Who are the stakeholders in the water conflict?

Pre-class assignment 1 [40% of grade assigned to this class]

Read an online newspaper article or report that describes stakeholders' opinion about the DMWW lawsuit. Pick one stakeholder of your choice and write a one page summary that includes your response to the questions provided below. You are free to pick an article/report published any time after March 2015. Please include a web-link of the article/report in your assignment.

1. What is the stakeholder's position on the DMWW lawsuit?

2. What are some of the action/s that the stakeholder has taken in response to the lawsuit?

Grading criteria: Students' ability to demonstrate an understanding of the stakeholder's position/response on/to the lawsuit. For example, are students able to identify a relevant stakeholder in the lawsuit? Are students able to clearly explain the stakeholder's position on the lawsuit?

Pre-class assignment 2 [40% of grade assigned to this class]

Based on your understanding of the journal articles assigned for this class, provide a maximum one page response to the following questions:

1. What factors determine farmers' adoption of conservation practices?

2. What factors determine farmers' participation in federal conservation programs?

Grading criteria: Students' ability to synthesize findings from the two assigned journal articles. For example, are students able to identify the relevant variables?

In class group assignment 3 [20% of grade assigned to this class]

The stakeholder typology students create as a group will be graded and every student in a given group will be awarded the same point/grade.

Grading criteria: Student group's ability to identify a suite of relevant stakeholders and place them correctly with respect to 'affecting', 'affecting and affected' and 'affected' categories. For example, farmers could potentially be placed under 'most affecting' category.

Class 2. Socio-environmental synthesis of the water conflict

Post-class assignment: [not graded, but to be included with your final assignment; see below]

Based on the discussions we had in the class, develop a refined mental model about the issue of dead zone in the Gulf of Mexico.

Summative assessment:

Class 3. Working together in the wake of a water conflict

Post-class assignment:

Students will write a 2-3 page report on their overall understanding of the social and environmental components of the Iowa water quality conflict, as well as how this watershed scale conflict situates within water quality in the Mississippi River Basin and the dead zone in the Gulf of Mexico. This report will include the refined mental model students created after the second class. As students write the report, they should keep the following points in mind:

1. Present an overall stakeholder perspective. Do not limit your views to the stakeholder role you were assigned in the class.

2. Ensure that you situate the Iowa water quality conflict within the bigger downstream water quality issues.

3. Propose a solution to the Iowa water quality conflict. Your solution could be policy based and/or any idea you may have. Be creative!

Grading criteria: In their mental model, student should demonstrate an overall understanding of the issue of Iowa water quality conflict and Gulf of Mexico dead zone as a system. Are students able to demonstrate the importance of scale (watershed vs. basin) in addressing socio-environmental problems? In their report, the student should be able to demonstrate an understanding of positions/responses of a diverse set of stakeholders.

10. Background

While interviewing Richard, a farmer in Iowa, he quipped, *"…. I'm trying to, piece by piece, let's get it* [the water] *cleaned up before Ames* [a downstream city] *gets on us!"* Richard was describing his efforts to reduce nonpoint source pollution runoff from his farmland. As per scientific estimates, it will cost $1.2 billion annually over five decades for farmers like Richard to establish the conservation infrastructure needed to offset environmental impacts associated with Iowa's intensive farming (Iowa Drainage District Association, 2015b). Iowa is the leading producer of corn, soybean, egg, pork and beef in the country. Richard's quip was shortly followed by his recollection of the lawsuit filed by the Des Moines Water Works. He said, *"…You might want to shut your tape recorder off if you get me talking about that* [lawsuit]*…"* The palpable anger and frustration is a classic example of response from an upstream stakeholder on getting blamed by a downstream stakeholder for the quality of water downstream. Emphasizing the importance of everyone to cooperate in solving the collective action problem of managing water quality, Bryan, another farmer from Iowa, mentioned,

"…cooperation is better than lawsuits…because if you get sued-- I haven't heard too many farmers that have had anything good to say about [the Des Moines Water Works lawsuit]. *But I think doing something for water quality is important. But by the same token, in this area, you got to have tile drainage in order to make the land productive. So then you got to decide, ""Well, is nitrate in the water worse than starving to death?""*

Famers like Richard and Bryan represent the predominant upstream narrative of anger and frustration, especially given their voluntary efforts to curb NPS pollution from their farmland. However, a situation of conflict, manifested in the form of DMWW suing drainage districts, is a result of the belief that such voluntary efforts may not be sufficient to protect water quality. Expressing his discontent with the effectiveness of voluntary conservation efforts to curb NPS pollution runoff, the current CEO of DMWW mentioned, "*The ultimate issue is whether we believe the voluntary techniques will protect the source waters. We disagree with that. The victories our country had in air quality, phosphates in detergent, etc., happened due to regulation*." (Quoted in "Your guide to the Water Works lawsuit," n.d.).

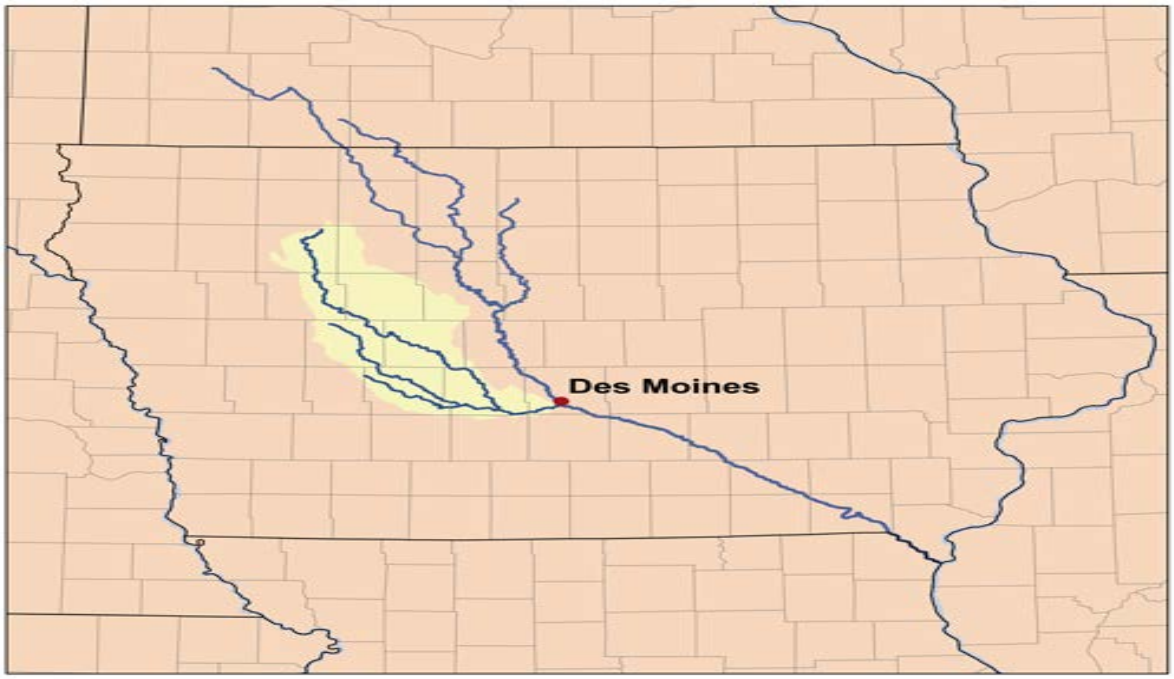
The lawsuit, as indicated by a poll conducted in February 2016, was supported by 60% of Iowans (Eller, 2016). The poll also found that 54% of Iowan feel that voluntary efforts to remove nitrates are insufficient. A predominant narrative, but definitely not the only one, fueling support for the lawsuit was that water quality is a "*matter of public health*."

In conflicts involving upstream-downstream stakeholders, it is not uncommon to find voices and narratives both in support and against the collective problem. While these voices and narratives are often at the extremes, they are also sometimes indicative of the complexity of the problem at hand. For example, Bill, a farmer from Iowa, mentioned, *"I do feel that it is our obligation as a farmer to look out for who's getting the water downstream from us. I don't want to see regulations that a farmer has to meet, but I don't know how you're going to get there without regulation."*

Problem statement – the lawsuit

Nonpoint source (NPS) pollution is a type of pollution that arises from several dispersed activities and is not traceable to a specific source. Runoff from agricultural fields is treated as NPS pollution because pollutants such as nitrogen and phosphorous cannot be traced to a specific farmland. Point source pollution, on the contrary, is traceable to a specific source. For example, pollution discharge from a wastewater treatment plant. The first major U.S. law to address water pollution was the Federal Water Pollution Control Act of 1948. This law was comprehensively modified in 1972 and the amended law became commonly known as the Clean Water Act (CWA). The act regulates point source pollution through the National Pollutant Discharge Elimination System (NPDES) permit program. NPDES permits are issued by either the Environmental Protection Agency (EPA) or a state/tribal agency

authorized by the EPA. In Iowa, NPDES permits are issued by the Iowa Department of Natural Resources. These permit allows, for example, a mining company to obtain and use water from a stream, designated as 'waters of the United States' under the CWA, and return polluted water to the stream.



Raccoon River Watershed, Iowa (*highlighted in yellow)*. Credit: USGS GNIS

Farmers across the Midwestern United States, including Iowa, have subsurface drainage tiles – perforated pipes made of clay, cement or plastic, on their farmland which helps remove excess water from soil subsurface. Water from drainage tiles flow into drainage ditches, and subsequently into the Raccoon River, which, in this case is the source of drinking water for the downstream residents in Des Moines and its surrounding areas. Drainage tiles and ditches constitute the drainage infrastructure, which drainage districts have the authority to improve, construct and maintain. The DMWW lawsuit contended that the 10 upstream drainage districts were in violation of the CWA due to their alleged discharge of nitrates, a common pollutant in agricultural runoff[7], into the Raccoon River and failure to obtain NPDES permit. Nitrate in drinking water is a health hazard associated with cancer and miscarriages. Water utility companies, such as DMWW, are thus required to meet federal standards in drinking water they provide to their customers. Water monitoring at samples sites across the 10 drainage districts showed nitrate levels as high as 39.2 mg/L, which is nearly 4 times the federally mandated limit of 10 mg/L ("Des Moines Water Works Responds to Iowa Supreme Court; Federal Permit Lawsuit Continues," 2017). In the lawsuit, DMWW sought damages and penalties from the drainage districts for the costs incurred in removing nitrates from drinking water. The lawsuit contended that agricultural drainage tiles were disrupting the

[7] Agricultural runoff is water leaving farmland due to rainfall and/or snowmelt.

natural conditions that otherwise treat nitrates and keep them from entering downstream waterbodies. Although agricultural runoff is exempt under CWA, the lawsuit contended that because drainage tiles artificially drain groundwater, drainage districts should be required to obtain NPDES permits. The lawsuit aimed to have drainage districts, and indirectly farmers, regulated as "point sources" under CWA.

On March 17, 2017 a U.S. District Court judge dismissed the lawsuit[8], among others, on the ground that drainage districts have immunity under the Iowa Law from the claims made by DMWW. The judge ruled that since drainage districts do not have the power to regulate farmers' use of nitrates, they cannot be held accountable for redressing DMWW's alleged injuries.

A socio-environmental synthesis of the water conflict/lawsuit

Intricacies of and interactions between the social and environmental components of water quality management, including interdependency of resource users, becomes evident in the DMWW lawsuit. Interdependency of resource users in this case manifests in terms of how actions taken by upstream water users[9] impacts downstream water quality and subsequent use. Example of an action taken by upstream water users that impacts downstream water quality includes, but is not limited to, application of fertilizer on farmland. Specifically, in the case of DMWW lawsuit, nitrate in fertilizers applied on farmland is the "source" of water pollution and drainage system is the "carrier" of the pollutant downstream. Whereas drivers of agricultural runoff, such as rainfall, snowmelt, etc. and how runoff impacts downstream water quality, represents the environmental component, farmers like Richard, Bryan and Bill, among other stakeholders, represent the social components of the water conflict.

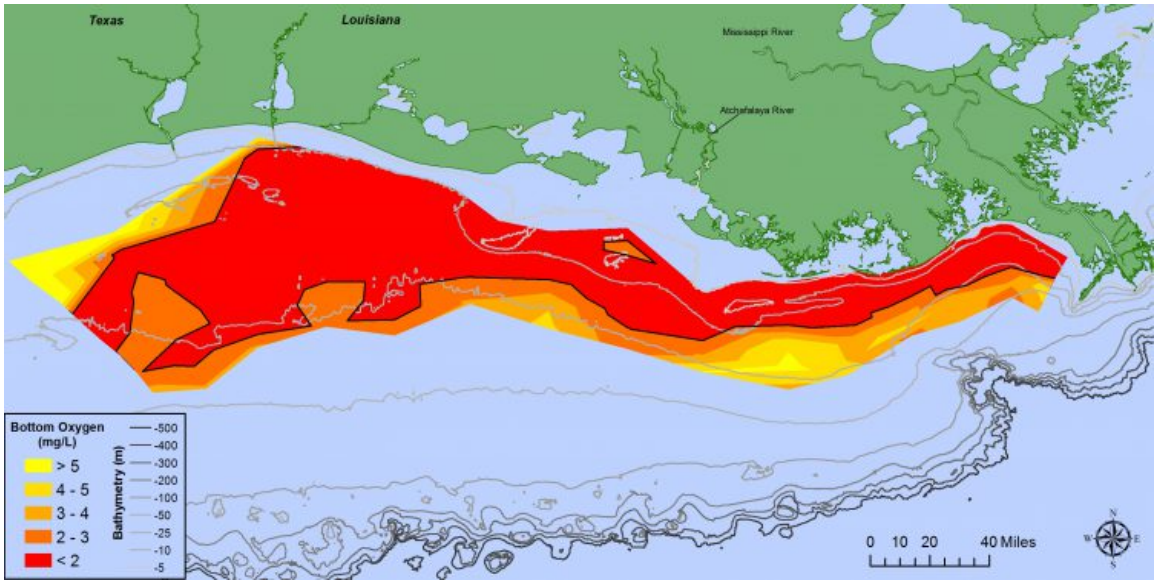
Environmental component of the water conflict includes several interdependent environmental factors. For example, fertilizer application by farmers and the resulting runoff is often a result of rainfall, which is sporadic. Expressing how sporadic rainfall contributes to the water conflict, an Iowa businessman mentioned, *"We have some fundamental issues like sporadic rainfall in Iowa. Bill Stowe* (Des Moines Water Works CEO) *and a farmer in the Raccoon River valley can't control whether we get 13 inches in a week or we get three-tenths of an inch. So that affects leaching and all those things associated with it."* Leached nutrients[10], such as Nitrogen and Phosphorus, flow through drainage systems into the Raccoon River, a source of drinking water for the downstream residents in Des Moines and

[8] Because the focus of this case study is on providing a socio-environmental synthesis of the water conflict, the grounds of lawsuit dismissal is not described here in detail.

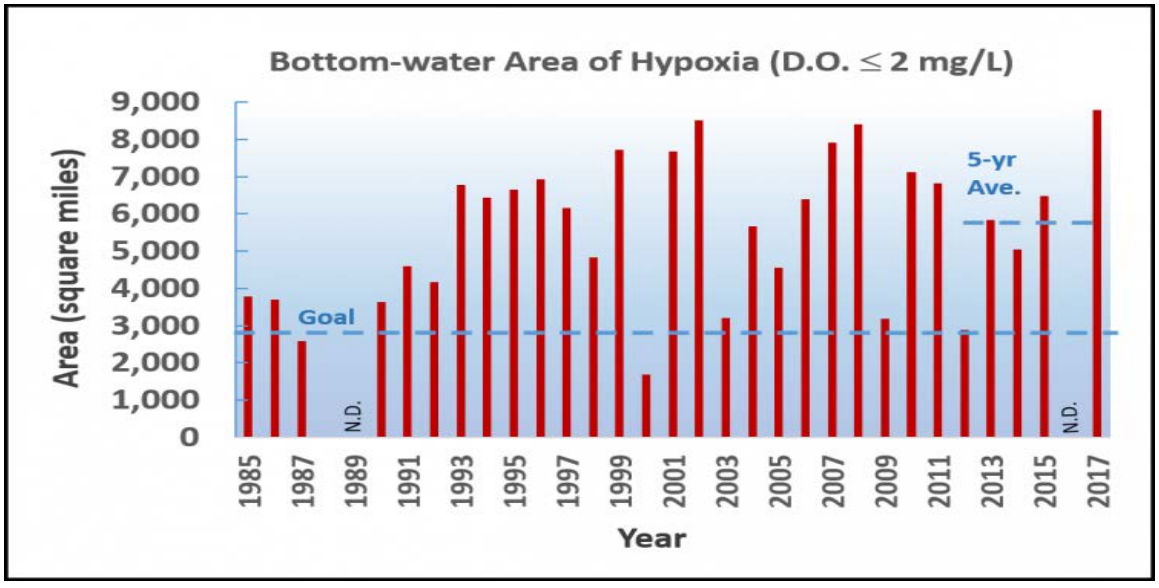
[9] Please note that farmers "use" of water is in the form of using the drainage system to obtain the benefit of improved drainage (Ranjan & Koontz, *In Press)*. Drainage districts "use" of water is in the form of improving, constructing, and/or maintaining the drainage system.

[10] Nutrient leaching refers to the downward movement of dissolved nutrients in the soil profile. The amount of nutrient leaching is not only a function of rainfall, but is also dependent upon, among other factors, the amount of fertilizer applied, and the timing and rate of application.

its surrounding areas. Raccoon River is a tributary of Des Moines River, which flows into the Mississippi River and the Mississippi River eventually in the Gulf of Mexico. Due to the interconnectedness of water systems, agricultural runoff from the fields of nearly 90,000 farmers in Iowa, including farmers in the Raccoon River watershed, contribute to the dead zone[11] in the Gulf of Mexico.



Area of hypoxia on Louisiana Gulf of Mexico shelf in 2017.
Credit: LSU/LUMCON and NOAA.



Measured size of hypoxia zone on Louisiana Gulf of Mexico shelf, 1985–2017.
Credit: LSU/LUMCON and NOAA.

[11] Insufficient levels of dissolved oxygen in water results in hypoxia, commonly referred to as dead zone. Eutrophication, the enrichment of a water body with excessive nutrients, results in harmful algal blooms, which subsequently, among other factors, contributes to hypoxia.

Social component of the water conflict includes a diverse set of stakeholders, who can be classified on the basis of their geographic location (upstream, downstream), their stance on the water conflict (in favor, against, or neutral), as well as on the basis of blame attribution, i.e. whether they take/give the blame for the poor water quality in the Raccoon River. The social components of the water conflict, for simplicity and to facilitate learning, can be broken down to the following two core stakeholders – upstream farmers and downstream residents in Des Moines and its surrounding areas. As described earlier, nitrate in the fertilizer applied by farmers, contribute to the poor water quality in the Raccoon River. In order to address pollution resulting from agricultural runoff, farmers voluntarily implement conservation practices that address soil erosion and the resulting leaching of nutrients. However, the counterargument in this water conflict is that such voluntary conservation efforts are insufficient to protect water quality. Subsequently, narratives surrounding the water conflict indirectly puts the blame on farmers for high level of nitrates in the Raccoon River. As described earlier, this often results in expression of anger and frustration by farmers like Richard and Bryan who are making efforts to improve water quality by adopting conservation practices. Residents in Des Moines and its surrounding areas are the downstream consumers of water from the Raccoon River. It is important to note that these residents could represent a diverse set of stakeholders, both in favor or against the lawsuit. However, the commonality between the two core stakeholders is that the actions taken by the upstream stakeholder directly impacts water consumption by the downstream stakeholder.

The social components of the lawsuit itself could be broken down to the following two core stakeholders – upstream drainage districts and downstream water utility company, DMWW. The commonality between these two stakeholders is that they both manage water for their clients, viz. drainage districts for farmers and DMWW for city residents. Both these stakeholders act in the capacity of providing service to their clients. For example, drainage districts serve farmers by constructing, maintaining, and improving drainage systems. Similarly, DMWW serves city residents by providing them with drinking water. Both these stakeholders transfer the costs of their services to their respective clients. Drainage districts have the authority to tax farmers for the services rendered. Similarly, DMWW transfers the cost of water filtration and provisioning to city residents in the form of their water utility bill. From a policy perspective, DMWW is regulated under the CWA. The water utility company applies for the NPDES permit in order to withdraw water from the Raccoon and Des Moines Rivers, filters the water and supplies it to the city residents, then discharges the unfiltered water back into the river. Drainage districts, on the other hand, are not regulated under CWA and subsequently do not require the NPDES permit.

The common resource that interlinks the four predominant stakeholders is water quality, or lack thereof. Behavior of these stakeholders is interconnected. For example, application of fertilize helps a farmer either increase or maintain productivity. However, as described earlier, this behavior has implications for downstream water quality. Deteriorating water

quality resulted in DMWW suing drainage districts, who are responsible for maintaining drainage tiles, the "carrier" of nitrates downstream. High level of nitrates in the river results in DMWW incurring costs to clean the water and make it potable. The cost of running the water filtration system gets transferred to the city residents. Similarly, if the drainage districts are required to obtain NPDES permit, the cost of obtaining the permit will get transferred to farmers. Thus, actions taken by stakeholders in this situation of water conflict, affect each other, both directly and indirectly.

Scale of water conflict is another important feature of the socio-environmental synthesis presented here. At a small scale, i.e. at the scale of the Raccoon River Watershed, the issue is that of incurring higher costs of removing nitrates from the Raccoon River and making the water potable for city residents. At a large scale, i.e. at the scale of the Mississippi River Basin, which includes the Raccoon River Watershed, the issue is that of managing water quality in order to deal with the issue of dead zone in the Gulf of Mexico. From a social dimension, watershed scale narratives surrounding the water conflict, usually that of blame-game, also contribute to the narratives around managing water quality across the Mississippi River Basin. In the water conflict described here, whereas the lawsuit itself involves two water managing bodies – DMWW and drainage districts, the social brunt of water conflict often trickles down to farmers.

Although the lawsuit was dismissed in March 2017, does it also indicate the dismissal of lawsuit engendered narratives surrounding it? Was lawsuit dismissal a win for the drainage districts and farmers? Probably not, as expressed by the owner of a business and a farm in the watershed, *"Sorry, there are no real winners in court."* While anger and frustration over the lawsuit often fuels blame-game, it also drives and in some cases even reinforces, farmers' intent to continue to undertake conservation efforts. For example, while interviewing a farmer from Iowa, they mentioned, *"Just because the city of Des Moines lost their lawsuit doesn't mean we* [farmers] *shouldn't be taking care of things. If they're* [other farmers] *doing practices that are polluting…a multitude of producers* [farmers] *should be doing more."* Another farmer, expressing a similar theme, mentioned, "[the lawsuit was dismissed]...*but those things could happen more often if we don't start doing more conservation."*

Policy responses/conservation efforts[12]

Agricultural conservation policy in the United States predominantly relies on farmers' voluntary conservation efforts (Reimer & Prokopy, 2014). Conservation programs in the country are primarily incentive-based (Reimer & Prokopy, 2014). For example, the Environmental Quality Incentives Program (EQIP) offers financial and technical incentives to farmers for voluntary adoption of conservation practices. As described in this study, the predominant rationale behind filing the lawsuit was DMWW's contention that voluntary

[12] The details provided here are not exhaustive. Only policy responses/conservation efforts in relation to the lawsuit are briefly described here.

conservation efforts are insufficient to protect water quality. One of the first responses to DMWW's filing a notice of intent to sue was the announcement by Tom Vilsack, US Secretary of Agriculture at that time, that Iowa would receive $3.5 million under a federal conservation program to promote voluntary conservation efforts (Iowa Drainage District Association, 2015a). More recently, in January 2018, Iowa legislature passed a water quality bill committing $282 million to water quality initiatives over the next 12 years (Pfannenstiel & Eller, 2018). The bill will provide $156 million in incentives for farmers to adopt a suite of conservation practices. The remaining $126 million will be provided to cities and towns to improve drinking and wastewater facilities. The water quality bill is intended to complement Iowa's Nutrient Reduction Strategy, a program implemented in 2013 with the goal of 45% reduction of statewide nitrogen and phosphorus runoff contributing to the dead zone in the Gulf of Mexico. A critique of the strategy in achieving its intended goal, among others, is that it relies on farmers' voluntary conservation efforts. As mentioned earlier, one of the main reasons behind filing the lawsuit was the belief that such voluntary efforts may not be sufficient to protect water quality.

11. **Suggested Modifications**

The case study can be modified in several of the following ways:

1. For a graduate level course with additional sessions, the instructor can include a contrasting case of water quality management where upstream-downstream stakeholders successfully worked together. Adding a contrasting case will enable discussions around factors that enable stakeholders to successfully work together.

2. Depending upon the learning objectives the instructor has in mind, they could switch the order of class 2 and 3. Doing so will allow a greater focus on the Gulf of Mexico dead zones and put additional emphasis on scale of environmental problems.

3. Although the role play activity has been limited to Iowa in this case study. It could be modified to include a wide range of stakeholders in the Mississippi River Basin. The role play activity itself is scalable to facilitate dialogue around the Gulf of Mexico dead zones.

4. For graduate students, this case study could also be used to describe several theories, concepts and frameworks applicable water management issues, including, but not limited to – collective action dilemmas (Ostrom, 2003), hydrosolidarity (Lundqvist & Falkenmark, 2000), and SES framework (Ostrom, 2007).

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13. **Answer Key**[13]

An answer key is not provided here because questions provided in the case study are simply examples of questions the instructor could pose. Moreover, given the open-ended nature of the questions, it is difficult to provide a 'correct' response/answer key.

14. **Acknowledgements** – "*This work was supported by the National Socio-Environmental Synthesis Center (SESYNC) under funding received from the National Science Foundation DBI-1052875*".

[13] Adapted from the National Center for Case Study Teaching in Science