# Pursuing the Promise of Case Studies for Sustainability and Environmental Education: Converging Initiatives

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Today's global environmental problems defy simple solutions and are often characterized as "wicked," signaling that we have arrived at a moment in human history when we can no longer proceed with business as usual. In higher education, changes in approaches to teaching, learning, and research are needed to address these wicked problems [1]. In particular, bridging disciplinary divides and the divide between research and practice are essential to find feasible solutions [2]. These transformations require engaging practitioners from outside university communities, as practiced in transdisciplinary research.[1] They also require equipping students with the necessary competencies to engage in truly integrative, interdisciplinary work [3]. Although interdisciplinary [4] and transdisciplinary works are on the rise, these approaches still run counter to traditional research practices that necessarily impose boundaries due to the disciplinary structure of most academic institutions, from metrics for success, to the way that we teach.

Despite general agreement on the direction the ongoing transformations in society and scholarship should lead, the pedagogical approaches required to achieve this vision have been less defined. Broadly, there is clarity on the need to shift away from the strict lecture-based approach that has been the predominant instructional method in higher education for centuries and toward the increased use of active learning methods, which have been shown to pro-duce better student outcomes [5]. While some instructors continue to see a role for lectures in higher education [6], the call to move toward active learning has gathered momentum over the last decade, particularly in STEM (Science, Technology, Engineering, and Mathematics) fields such as biology [7]. Within the broad approach of active learning, however, there is less clarity on best practices and methods for teaching about complex environmental problems. The fact that each of our organizations has independently invested in developing case studies and focused our attention on case study teaching is noteworthy: our collective convergence reflects a broader recognition of case studies as a promising approach. As articulated by Editor-in-Chief, Dr. Wil Burns, in the prospectus for this journal, case studies are a natural fit for the inductive way that most students learn. They also promote critical thinking and give students opportunities to practice defining a problem, recognizing stakeholders, and crafting solutions [8]. These are all critical elements for effective teaching about complex environmental problems, and therefore, case studies offer great promise for educating and training environmental problem solvers. In this commentary, we introduce each of our efforts to develop case study teaching materials and pedagogies, and we highlight common challenges, solutions, and lessons learned from our collective experiences in leading our respective initiatives.

1. As described by Mobjörk 2010 [30], both transdisciplinary and interdisciplinary research require integration, which distinguishes them from the "division of labor" approach of multidisciplinary research. Transdisciplinary research differs from interdisciplinary research in the explicit inclusion of actors beyond the academic community in knowledge production and use.

## THREE CASE STUDY INITIATIVES

The pedagogical use of case studies is well established in the fields of medicine, law, and business. Each of these

fields has a distinctive approach to teach with case studies, characterized by a common set of teaching methods. In the sciences, the National Center for Case Study Teaching in Science [9] has developed a broader set of pedagogical methods that can be applied across the sciences, many of which are relevant for the environmental sciences. However, although case studies have also been used in many environmental courses, the inherently interdisciplinary nature of environmental problems has led to less clarity on which methods work best for teaching about environmental issues. There is also a lack of clarity about what other methods are employed and whether new pedagogical methods are needed. Moreover, sources for relevant cases have been scattered, and conversations about teaching with cases have been similarly dispersed. The creation of this journal stems in part from the recognition of the need for a curated and dynamic central source for environmental case studies and the need to better define their structure and share best practices. Similarly, each of our organizations has recognized the potential of the case study approach and has thus invested substantial resources to develop case study materials and to advance case study teaching in the environmental arena.

At the National Socio-Environmental Synthesis Center (SESYNC), a center that facilitates synthesis research to advance understanding of socio-environmental (S-E) systems, the decision to focus on case studies for teaching about S-E synthesis was driven by a need to provide clear examples to illustrate complex ideas in a tangible way. S-E synthesis is an interdisciplinary, system-focused research approach that requires a broad range of competencies and methods. Given this, the flexibility of the case study approach is attractive as it allows cases to be adapted for the wide range of learning goals. The case study approach is also a good pedagogical fit because it can be adapted for a broad range of topics, audiences, and classroom formats. To fulfill a need for teaching materials specifically targeting the teaching of S-E synthesis [10], in 2013, SESYNC developed a short course on *Teaching about Socio-Environmental Synthesis with Case Studies*, which brings a diverse group of researchers and educators together to write case studies for teaching. Currently, there are 50+ cases in the SESYNC Case Study Collection, all of which are Creative Commons licensed and freely available at http://www.sesync.org/for-you/educator/case-study-collection. This collection aims not only to provide diverse examples of specific S-E problems but also to provide examples of the many ways in which one can engage students in the classroom with a case study, as well as detailed practical advice for implementing case study activities in the classroom.

Michigan Sustainability Cases (MSC) was launched in early 2016, following a successful proposal to the University of Michigan's Transforming Learning for a Third Century (TLTC) initiative (a university-wide program to encourage engaged learning) that was a collaborative effort between faculty and students. Drawing from decades of in-house experience in teaching with and using cases, a few key faculty members in the School of Natural Resources and Environment wrote the initial proposal, which aimed to transform sustainability education by importing cases more fully into the field. Students then expanded on faculty members' ideas and added innovative elements such as multimedia and experiential learning activities to the traditional case format. Together, this early team sought to upend the current paradigm of lecture-based content delivery, and MSC began to create case studies focused on real-world decisions that would promote more engaged learning in the classroom, greater knowledge retention, and better inclusion of diverse learners. Case production is ongoing and occurs through collaborative teams of students, faculty, and practitioners. Completed cases are subsequently published on a multimedia-enhanced online platform at learngala.com, which provides students an immersive and applied learning experience. In this way, student learning in the case production process is connected directly to student learning in the classroom. Recently, MSC has begun to explore how case studies might be used outside the classroom to educate the wider public and to generate solutions to pressing environment and sustainability issues.

Similarly, the Yale School of Forestry & Environmental Studies (F&ES) launched its Case Study Integration Initiative in 2015 to provide faculty and students with cross-cutting, online resources around central, ongoing natural resource management challenges. These new cases allow faculty to cover applied topics through their courses, providing students with curricular common threads. Opportunities to bring varying perspectives together for problem-solving exercises are always prioritized. Largely, the initiative seeks to serve as a resource for both faculty and students by providing faculty the iterative curriculum support that allows them to cover compelling case studies and giving students the kind of real-world activities they

demand. Key components of the F&ES program are the emphasis on integration of individual case studies across multiple courses, the provision of individual faculty support, and broader guidance for implementing cases.

As we describe below, the format and emphases of the cases in our respective collections vary, but despite such differences, our initiatives represent complementary efforts and face similar challenges and opportunities.

## COMMON CHALLENGES AND ACQUIRED INSIGHTS

*Designing Cases: Selecting Case Study Formats*

One fundamental challenge in creating a case study is to determine how the cases should be structured and presented. While a case study in its most distilled form "involves investigation of [a] 'real-life phenomenon through detailed contextual analysis of a limited number of events or conditions, and their relationships'," [8] the structure and content of cases vary widely. Some cases provide in-depth details and context about a particular event, problem, or issue. Typically, students learn specific principles and concepts that are illustrated by the case through guided examination and discussion. On the other end of the spectrum are cases where a problem is introduced, but many details related to the case itself are uncovered by the students. These types of cases, which are typical of problem-based learning (PBL) and case study teaching in the medical field, provide rich opportunities for students to explore, analyze, and research issues on their own and represent a constructive learning experience. Similarly, there is a range in terms of the degree of teaching direction provided with cases; some cases provide a few discussion questions, whereas others provide detailed teaching guidance. All the various formats have utility, but how a case should be structured and presented depends on the purpose of a particular case and its institutional context. As described below, differences in goals and institutional contexts across our three organizations have led to different decisions on how to structure and present the case studies in our respective collections.

For SESYNC, the main purpose of developing a collection of case studies is to engage students in learning about S-E issues and to help students develop specific competencies related to S-E synthesis. To this end, SESYNC cases are designed as teachable units [11] where learning objectives, assessments, and activities are articulated and aligned. Following the lead of the National Center for Case Study Teaching in Science, which has a well-established collection of peer-reviewed case studies in science, SESYNC cases reflect an emphasis on active learning and the thoughtful design of how students will engage with the content of the cases. The cases are formatted to include a set of detailed teaching notes, student handouts, and supplementary materials. The teaching notes are particularly important in SESYNC cases as they contain teaching tips and are intended to be updated with insights gathered from experiences in teaching the case. Within this format, there is a great diversity in the structure and presentation of the cases.

With its cases, MSC opted for a detail-rich, multicomponent format to convey the complexity of sustainability issues and to prepare students to solve sustainability problems. A comprehensive narrative describing a difficult choice faced by a decision maker forms the backbone of each case. A variety of multimedia elements support the narrative and contribute to more inclusive learning by catering to different learning styles and by providing greater accessibility for learners who may respond less well to traditional content delivery modes such as textbooks. In addition, an interactive discussion tool enabled within each case allows users to share knowledge and perspectives across classrooms and across professional and academic communities. Each case includes teaching notes that can be updated with instructor comments and insights and an engaged learning exercise that helps students to unpack a case or teaches them critical skills such as stakeholder conflict resolution. Together the case components are intended to form an instructional package capable of deployment within and outside university classrooms. Although the cases currently follow a standard format, the online presentation is amenable to updates and innovations as the initiative evolves. Thus, the learning platform (learnmsc.org) plays a central role in advancing sustainability pedagogy and, through its interactive features, contributes to the goal of bridging research and practice.

Cases in the F&ES collection emphasize student learning and engagement with sustainability issues through cases but in a slightly different way. Like MSC, F&ES cases are also presented as detail-rich, online resources that allow students to explore a variety of modules covering disciplinary and stakeholder perspectives on a central challenge. Rather than focusing on providing a single set of teaching notes for each case, F&ES case efforts focus more

broadly on how cases can be integrated into multiple courses within the school's curriculum. A general set of guiding questions provides faculty case users with a starting point for discussion for the entire case and each module, and the case study team works directly with each faculty member on individually tailored resources as needed. Thus, professors are able to determine how to best cover the case given the time available and subjects covered in their course. As multiple instructors use the same case in different ways, F&ES's initiative also seeks to uncover best practices and improve cases over time.

*Designing Cases: Aligning Learning Goals and Activities*
Regardless of the structure and format of a case, the first step for instructors in using a case is to determine what they want students to learn. This is typically formalized through learning goals, which are often provided by case study authors. Given the broad suite of competencies and concepts associated with environmental problem-solving, articulating such learning goals is often a challenge. We agree that the appeal of case studies comes from their real-world relevance and their tangible illustration of the complexity of environmental problems. By examining cases, students can learn about the challenges presented by a particular environmental problem, factors influencing the problem, stakeholders involved with the problem, and potential or actual solutions. But case studies have the potential to go further: They can also help students develop critical competencies needed to tackle environmental problems, including mastery of process skills such as interdisciplinary communication or working in teams. Thus, the challenge of writing learning goals for a particular case forces one to consider more deeply what we want students to learn.

Closely coupled with the articulation of learning goals is the decision of how students will achieve these goals. Given the many ways that students can engage with cases, another challenge for instructors is to decide which activities and methods are best suited for facilitating the desired student learning outcomes. For learning critical process skills, active learning methods are particularly effective given the opportunities they provide for students to learn by doing. For example, one active learning method commonly used in case studies is the jigsaw, a method that helps students to understand and work with differing perspectives. In a jigsaw exercise, students are assigned roles to become experts on a particular aspect of a problem or rep-

resentatives of a particular viewpoint. The students then bring this newly acquired knowledge and perspective to a group exercise where they are challenged to combine their different expertise—their jigsaw pieces—to arrive at a collective decision about the problem. Jigsaws provide practice in listening and appreciating differing viewpoints and negotiating decisions with groups, where all competencies are important for environmental problem-solving. There are many other active learning methods (for classification scheme of "case study methods," see [9]), and one of the SESYNC's goals is to identify which methods are particularly well suited to teaching environmental competencies. Through the challenge of deciding what students should learn and how they will learn it, instructors must reflect on approaches to teaching with case studies. In doing so, we see potential for individuals to help identify areas where existing pedagogies may be insufficient and perhaps to develop new teaching methods [12].

*Designing Cases: Organizing Materials for Flexible Use*
Through the work of creating cases for our respective collections, we have also gained many insights into the process of designing cases and implementing them in the classroom. Perhaps the biggest challenge, and one common to all our efforts, is managing the scope of the case. Given the multifaceted nature of the topics, environmental and sustainability cases tend towards complexity and tend to be long. At the same time, focus and clarity are needed. We have found that an effective solution to this tension is to organize the case in a modular fashion where the elements are presented as a scaffold, and deeper explorations into various aspects of the case are presented as branches from that scaffold. In MSC cases, this can be seen in the supporting multimedia features (podcasts and Edgenotes, which are curated content displayed alongside narrative text). In SESYNC cases, optional, deeper explorations are contained in sections titled "suggested modifications," where the author provides additional information and suggested activities for deeper study of a particular aspect of the case [10]. At F&ES, in addition to guiding questions, each background module includes a list of suggested resources (maps, websites, videos, reports, peer-reviewed literature, etc.) that help students dive further into subtopics. This organizational scheme with optional or supplementary modules allows for adaptation of the case to different audience levels and courses. This is particularly important for allowing these cases, which are inter-

disciplinary in nature, to more easily fit into the curriculum of disciplinary courses.

*Using Cases: Supporting Case Study Implementation*
Developing high-quality case study materials is important, but the successful implementation of cases can also rely on institutional context and support. While case studies can help students and faculty explore crucial topics and develop needed professional skills, instructors can find it difficult to implement case studies, especially when they are considering using cases they have not developed themselves. Finding good cases has also been problematic given that cases are scattered across many sources, although we hope that the development of this journal and our three initiatives' libraries will make this easier. Once a case has been selected, an instructor must find ways to adapt it for his or her course, but this can be challenging. First, rearranging an existing syllabus to give adequate time for effective case use is not always possible. Second, faculty members often lament that they have so much core content to cover in a given course that finding time to devote to a case can feel daunting. That can be heightened when teaching a case study requires an instructor to leave his or her comfort zone, in terms of both research subjects and disciplinary expertise, as often happens given the interdisciplinary nature of environmental and sustainability cases. Third, writ large, effective case study teaching requires the practice of active learning strategies and necessitates unscripted, in-class exchanges between instructors and students. This can be a real challenge for the instructor if they do not have experience with active learning and requires support and practice. Overcoming these issues requires institutional support for innovation in teaching, such as creating reward structures for interdisciplinary and collaborative team teaching. It also requires mechanisms for educators to share best practices and teaching insights within and across university units, as we describe below.

*Paths Forward*
The process of designing case studies has highlighted several directions for future work that could help case studies to reach their full potential as a pedagogical approach for environmental and sustainability fields. Namely, we suggest that greater clarity in how we should teach is needed and that seeking broader engagement in case creation and dissemination will benefit environmental educators and students alike.

*Assessment and Evaluation of Case Study Pedagogies*
Determining effective ways to help students achieve the desired learning outcomes requires critical reflection about how well various pedagogies are working and for whom. With regard to case studies, some evidence exists that their use promotes knowledge gains [13, 14], critical thinking [15], and problem-solving skills [16, 17] and that the case use may be beneficial for first-generation college students [18]. Additional evidence indicates that teaching through cases and examples that provide "real-world" relevance (i.e., "socio-scientific issues") increases student's interest and engagement in learning [19–22] and promotes the development of higher order thinking [22]. The connection to the place-based, local issues has also been noted for its potential to engage the interest of underrepresented minorities [23].

However, gaps remain in our understanding of the effectiveness of case study methods in achieving desired learning goals for sustainability and environmental problem-solving. Much of the available evidence supporting case study use comes from investigations of PBL, which is a broader instructional method that varies in its implementation [24] and is often considered a type of case study method. Moreover, studies of PBL have mainly focused on the medical field. These features of PBL make it difficult to draw broad conclusions, and thus further empirical studies linking case study use to specific student outcomes relevant to environment and sustainability, such as the recently published study in this journal by Anderson et al. [14], could help to refine best practices in case study production and teaching. Future assessment efforts should also interrogate how the experience of using case studies differs (if at all) in environment and sustainability education. The need for such evidence is particularly acute in the environmental field given the growing emphasis on case studies and the urgency of developing effective pedagogies to help students learn critical competencies. Furthermore, many of the competencies necessary for tackling global environmental problems, such as the ability to work in diverse teams or the ability to integrate ideas from different disciplines, can also be more difficult for instructors to teach and assess. Although some strategies for the assessment of such interdisciplinary competencies exist [25, 26], more work needs to be done to develop assessment tools and to make them easily accessible to instructors at the college and university level.

*Building Learning Communities*

As our initiatives have grown, we have discovered that the process of designing case studies itself is a rich learning experience that we feel is worthwhile to share. Each of our initiatives has made efforts to bring teams together to write cases collaboratively, as well as to build a broader community of educators that can support each other in the design and implementation of case studies in the classroom. We have done this in a variety of ways: At SESYNC, the annual short course on teaching case studies provides a venue for building a base of engaged educators. Many course participants have continued their involvement by engaging in related workshops at SESYNC to further investigate issues related to case study teaching, including best practices for teaching S-E synthesis with case studies [27] and assessment of systems thinking and interdisciplinary skills. At the University of Michigan, a commitment to include practitioners as case authors promotes co-creation of knowledge across academic and professional communities, and, we posit, helps to train more effective problem solvers and to generate viable solutions to sustainability problems. In addition, the discussion tool enabled within the learning platform provides a space for dialogue to occur between these communities, and with local and global citizens.

Each of our organizations has crafted independent learning communities through our case study initiatives. However, given that environmental case studies are beginning to flourish, as evidenced by the creation of this journal, we see opportunities for building and supporting a broader learning community around case study teaching. For example, one way to build new communities is to create Faculty Mentoring Networks (FMN) modeled after the successful FMNs run by the Quantitative Undergraduate Biology Education and Synthesis network (qubeshub.org). These FMNs would facilitate a community of learning focused on improving case study pedagogy by engaging participants in a semester-long effort to adapt and implement existing case studies in their classrooms; participants would then share insights, solicit advice, and provide support to their colleagues through regularly scheduled virtual meetings.

Another way to support a learning community that can disseminate cases and introduce new instructional practices is by inviting case study authors to give in-person demonstrations of their case studies at campuses around the country. Authors are typically highly motivated to share their resources because they have a deep intellectual interest in the subject and, as a result, have devoted substantial time to develop the case. At the same time, instructors unfamiliar with case study use or specific case subject matter can benefit from being exposed to effective case study facilitation. With this in mind, at Yale F&ES, a SESYNC case study on REDD+ in Panama [28] was integrated into the annual International Society of Tropical Foresters conference in 2017, and the case authors were provided with funding to showcase their work. This allowed students and stakeholder participants to synthesize their existing expertise and newly acquired knowledge from the conference and apply both to the case study. Some in the room had extensive backgrounds in the topic area, while others were newcomers, but by working through the case study role-play exercise, all were able to apply the concepts covered by the event's panel discussions to a specific context. As this journal and the case study libraries of each of our initiatives expand, we hope to continue to share not just case materials but also teaching insights and experiences from many educators. This could prove especially helpful for faculty members at institutions without robust case study programs who are interested in writing or using cases.

As momentum continues to build around case studies, we are eager to connect with and learn from others who have been working to advance case study teaching in the environmental arena. Only with widely inclusive participation, will we succeed in refining best practices and nurturing pedagogical innovations for environment and sustainability education. Moreover, we have discovered that conversations about case studies also provide a platform for productive discussion about larger issues specific to sustainability and environmental education, including such challenges as defining core competencies for interdisciplinary environmental fields [29] as well as issues more broadly relevant in higher education, such as interdisciplinary integration and active learning. This journal provides an opportunity to engage in the growing dialogue, and we encourage you to join the collective conversation by submitting your articles to Case Studies in the Environment's Case Study Pedagogy and other sections. We also invite readers of this journal to explore the case study materials of our growing collections and to share other resources for case studies in the environment. We look forward to hearing your thoughts.

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