A Values Framework for Students to Develop Thoughtful Attitudes about Citizenship and Stewardship

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ABSTRACT

Geoscience teaching has primarily been oriented toward the value of science to explain natural systems. However, many kinds of values guide people's responses to environmental problems, which originate when human expectations fail to match the behavior of natural systems. Examples from the literature show that practical environmental decision-making recognizes, and is formed on the basis of, diverse values. We propose a 'values of nature' framework based on Stephen Kellert's (1996) values of life to provide a set of concepts and a terminology that engages students to recognize the values they bring to environmental issues. We show from our experiences in two different introductory courses that students using the values framework can develop thoughtful attitudes about the environment and can appreciate the views of those with different values.

INTRODUCTION

There is a long tradition in the geology community of education for informed citizens (e.g., Pogue, 1919; Palmer, 1990, Bertog, 2007). In most introductory geoscience courses students learn scientific ways of understanding and the practical benefits of the natural world. To what extent are future citizens and scientists served by introductory science courses that focus only on the methods and findings of science? We assert that, to further develop skills of citizenship and stewardship, students need to develop a more nuanced understanding of the ways in which people perceive, interact with, and value the natural world.

The need for citizens to thoughtfully consider values is made clear when controversial environmental issues are considered. Minteer & Collins (2005) suggested that managing biodiversity requires analysis of ethical questions; for Nie (2002, p. 65), the debate over wolf management in the U.S. can be "understood as a value-based political conflict that transcends issues strictly pertaining to science… A policy-oriented approach has much to offer" if it "places human values and ethics at the center of its analysis." The key role of values in guiding technical approaches to sustainable development was eloquently stated by environmental law expert John Dernbach (quoted by Friedman, 2008, p. 412): "the decisions Americans make about sustainable development are not technical decisions about peripheral matters, and they are not simply decisions about the environment. They are decisions about who we are, what we value, what kind of world we want to live in, and how we want to be remembered."

According to Dessler and Parsons (2006), a barrier to informed, effective deliberation of environmental issues is the tendency to confuse value-based claims for what should be done (*normative statements*) with claims about the world that correspond closely to the evidence-based statements of scientists (*positive statements*). They state that "…tangling of positive and normative claims… obstructs reasoned deliberations on public policy… Untangling them to the extent that is feasible… can often reduce conflict and identify bases for agreed action among people of diverse political principles," (Dessler and Parsons, 2006, pp. 22-23). For students, learning the scientific bases for positive statements such as reliance on evidence, the importance of peer review, and the concept of scientific consensus is necessary but not sufficient if they don't consider the values which form the basis of normative statements. Likewise, scientists need to discern and analyze the value statements of those they work with and for. We can help students become educated citizens if they learn the difference between positive and normative claims and to recognize, examine, and state the values that underlie their own normative claims and those of others.

Courses that seek to connect science to the real-world situations experienced by citizens need to meet two challenges that relate to valuing nature. First, the scientist-instructor may have come to the non-scientific aspects of the course over time and in a self-guided way, building great knowledge and enthusiasm but without developing a consistent framework in which to develop materials and to present information convincingly to non-scientists. Second, the students may come to the course with the perception that the only value that really makes a difference in today's world is economic value, and that non-economic considerations are not important. Furthermore, they are experienced consumers who are wary that non-utilitarian values may threaten their cell phones, iPods, and cars. Both instructors and students need a framework in which their dominant values, scientific and economic, respectively, can be balanced and coordinated with other values.

In the following sections, we present a values framework, followed by examples of how students are introduced to and apply the values framework, and the results of assessment of student learning of the values framework. Examples and results are drawn from two introductory courses taught at West Chester University, a public, comprehensive, predominantly undergraduate institution (61% female; 14% Black, Hispanic, and Asian; average age, 21 years). Students in both courses are predominantly non-science majors. First, we discuss a course on environmental issues (mainly related to energy) in which students use the values framework to better understand their own consumer choices. This course fulfills an interdisciplinary requirement in the University's general education program and is taught in three sections of 32 students each, in a lecture-discussion format. Then

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we discuss an introductory, general education course on geological hazards (volcanoes) in which the values framework helps students understand the world from the perspective of another person or culture, and to make decisions and act upon incomplete and uncertain information. This course is taught with a large-lecture and lab format for 90 students (three lab sections of 30 students each), and fulfills a science distributive requirement in the general education program.

A CONCEPTUAL FRAMEWORK FOR HUMANS VALUING THE NATURAL WORLD

Many disciplines contribute their unique perspectives to a large literature on values: philosophy, economics, psychology, sociology, political science, and environmental science; Dietz et al. (2005) provides an excellent review. One approach commonly found in environmental textbooks is one of contrasting centrisms: people's environmental ethical perspectives are categorized as anthropocentric, biocentric, or ecocentric (e.g., Withgott and Brennan, 2009). Although rarely acknowledged in environmental science textbooks, these categories are derived from the environmental ethics literature concerning altruism (Dietz et al., 2005). The values have a dual character: they refer to aspects of the natural world but also our perceptions of the world. Several instruments are used for empirical values measurement; the Schwartz Value Survey (Schwartz and Bilsky 1987, 1990), for example, has great validity and reliability and has been used in research on environmental values. However, we have not found it to be useful in teaching students about the values of nature for people. It is cumbersome (56 items) and few of the value items explicitly pertain to people's relationship with nature.

We have adapted a values framework that emerged from surveys conducted by biologist Stephen Kellert to explicitly probe people's responses to non-human living things (Kellert, 1996). Kellert's work has been criticized (e.g., Dietz et al., 2005) because it did not come from the disciplines that traditionally have conducted values research, it is not grounded in that theoretical or empirical literature, and Kellert (1993) hypothesizes a biologic basis for their values that is difficult to test. Nonetheless, we have found Kellert's Values to be an effective teaching tool to help students expand their understanding of the ways in which the natural world benefits people and how people's values influence decision-making.

Kellert originally proposed nine value categories – utilitarian, scientific/ecologistic, naturalistic, aesthetic, humanistic, moralistic, symbolic, dominionistic, and negativistic. A tenth category, theistic, was added from work by Mordi (1991; quoted in Kellert, 1996, p. 148). Kellert called these, "Values of Life," reflecting his perspective as a biologist; however, we frame them (Table 1) as broader descriptions of the ways people respond to the natural world and how they regard nature from within their worldview. The ten categories are relatively brief and simple, expressed in concrete terms, and can be used to focus specifically on people and the natural world.

To use a values framework effectively in the classroom it is important for the instructor to clarify two aspects that emerged from responses to Kellert's surveys. First, life experiences seem to be more important than factual knowledge in shaping attitudes toward nature and living diversity. Kellert (1996, Chapter 3) shows that values scores reflect factors such as gender, income, and ethnicity, and suggests that scores change with maturity and educational level. For example, a divide is found between U.S. urban and rural populations that relates to the amount of land people own, whether they reside in cities or in open country, and whether they make their living in a resource-related profession such as mining. Second, even within a population, the survey responses relating to a single value show a wide range. An analogy might be the 'comfort value' provided by air-conditioning in an office. To set the thermostat, occupants have to understand their individual temperature preferences— some people like it cooler than others— and then reach a compromise. Individuals don't change their preferences but they need to know and state their preferences on a temperature scale to engage in the compromise. The "values of nature" provide a vocabulary for students to state their preferences and a framework in which to recognize the values that are important to others.

APPLYING THE VALUES FRAMEWORK TO RESOURCE CONSUMPTION

A goal of Humans and the Environment, an introductory, interdisciplinary course that deals with sustainability issues is to teach students about the amounts of energy on which their lives depend, sources of energy, and the consequences of producing and consuming energy. The science-oriented content includes statistical information about U.S. energy sources and consumption patterns; fossil fuels and their relation to greenhouse gases, climate change, and other pollution issues; and comparison of energy consumption today relative to the past, and in the U.S. relative to the rest of the world. By itself this information tends to lead to formulaic class discussion and reflective writing: "We are poisoning the earth." "We are so wasteful." "We use too much energy." "We just can't live without coal and oil." My students see problems but their normative responses are vague and generic: the factual information does not prepare them to talk about why "we" would poison earth, be wasteful, use too much— or how "we" could address the problems that underlie these statements.

Kellert's value typology (Table 1) provides a framework in which a more nuanced discussion of energy consumption can develop. I support the framework with relevant, easily accessible material in which the students can recognize Kellert's values. Films seem ideal for this purpose because they can be shown in class and lead to immediate discussion. For example, I use Kilowatt Ours, an award-winning 2007 film that looks at the consequences of using coal to generate electricity in the U.S. Connections can be found to at least eight of Kellert's values:

- Utilitarian value—coal-burning power plants produce most U.S. energy; conservation, efficiency, and renewable energy can reduce the use of coal.
- Dominionistic value—obtaining the benefits of coal

TABLE 1. THE VALUES OF LIFE (KELLERT, 1996; MORDI, 1991)

Value	Brief Definition	Function
Utilitarian	Practical and material exploitation of nature.	Physical sustenance, security.
Naturalistic	Direct experience and exploration of nature.	Curiosity, discovery, recreation.
Ecologistic/Scientific	Systematic study of structure, function, and relationship in nature.	Knowledge, understanding, observational skills.
Aesthetic	Physical appeal and beauty of nature.	Inspiration, harmony, security.
Symbolic	Use of nature for language and thought.	Communication, mental development.
Humanistic	Strong emotional attachment and "love" for aspects of nature.	Bonding, sharing, cooperation, companionship.
Moralistic	Spiritual reverence and ethical concern for nature.	Order, meaning, kinship, altruism.
Dominionistic	Mastery, physical control, dominance of nature.	Mechanical skills, physical prowess, ability to subdue nature.
Negativistic	Fear, aversion, alienation from nature.	Security, protection, safety, awe.
Theistic	Nature reflects the will of supernatural forces or deities who govern destiny; fatalistic belief.	Order, meaning, security, awe.

depends on control of streams and slopes, and on access to coal-rich land

- Negativistic value—people explain how their lives are threatened by floods and mud flows in coal country; children talk about their struggles with pollution-induced asthma.
- Naturalistic and scientific value—a park ranger explains how the experience of the Great Smoky Mountains is changed by power-plant emissions that reduce visibility and poison plants with ozone.
- Humanistic and aesthetic value—a man describes how coal mining literally removed a mountain near his home. He's asked whether he has a picture of the mountain: "Why should you take a picture of a mountain, it's going to be there forever… at least I thought."
- Symbolic value—a town in Appalachia holds a Funeral for the Mountains to symbolize the loss of natural areas to coal mines.

The values provide a terminology to dissect the costs and benefits of coal exploitation in human terms that goes beyond economic cost-benefit analysis. Students can identify values issues raised in the film and can recognize their own concerns. For example, because they are beneficiaries of coal-generated electricity they can see that coal mining has a high utilitarian value for them. They can also see that arguments against mining, which might ordinarily be lumped in a broad "environmental" category, arise from the real-life experiences of people who live in mining country. For example:

- high negativistic values that result from health- or life-threatening aspects of mining and coal combustion
- high dominionistic values associated with control of dust, runoff, and mud
- lowered naturalistic and humanistic values from destruction of familiar natural landscapes and ecosystems.

The last part of Kilowatt Ours highlights actions that households, schools, cities, and businesses are taking to reduce electricity use and greenhouse gas emissions. Improvements in technology are highlighted, from Energy Star appliances and insulation to geothermal heating/cooling and wind power. In a writing assignment, students are asked about how they see themselves using these technologies in their homes given the increased expense. Although the question is directed toward their personal situation, students refer to ways in which their choice of technology will affect the value of life for those who live in coal country or who are affected by coal-generated emissions. In other words, consideration of values becomes part of their way of seeing technological choice.

APPLYING THE VALUES FRAMEWORK TO NATURAL HAZARDS

"Volcanoes," an introductory-level course, has some learning objectives related to the development of citizenship skills – students will be able to:

- evaluate the roles of volcanoes in human societies using a values-based framework;
- use a model of effective risk communication to evaluate case studies of volcanic hazards;
- use geological, demographic, and cultural information to assess risk and discuss strategies for managing risk associated with volcanic hazards.

Kellert's values provide a vocabulary and schema for students to analyze and express their understanding of human responses to the natural world and its hazards. The values framework is introduced, applied, and assessed in a variety of ways during the course, as outlined in Table 2.

Most students begin the course asking, "Why would anyone live near a volcano?" The values framework can help students develop answers to this question and

analyze how personal and cultural attitudes about nature can shape societal responses. Case studies of volcanic activity are presented using video and print media. Two excerpts from "The Volcano Watchers," an episode of the Nature television series are shown during class: one on the 1973 eruption of Eldfell volcano on Heimaey, Iceland, and the other on an eruption of Mt. Etna, Sicily. Students are asked to describe people's responses to the volcanic eruptions, and to categorize them using Kellert's Values framework (Table 2) in a think-pair-share activity. As a follow-up, students read about the response of a traditional indigenous population to an active volcano (Parícutin in Vulcan's Fury, Scarth, 2003) and analyze excerpts in class using the values framework.

After checking student work for general comprehension, it is essential for the instructor to clarify with the class those value terms that are confusing. The sources of confusion are several: some values, such as symbolic, are unfamiliar, while other value pairs, such as moralistic and humanistic, are similar but have distinct meanings. The video clips and readings cited here can help students tease out the differences and apply value terms correctly. For example, when Maurice Krafft describes the Eldfell volcano as being "like a wild animal and you are some kind of crazy doctor," or a lava flow from Mt. Etna "eating a building," students can more

TABLE 2. ASSESSMENTS USED IN ESS 125 VOLCANOES

Formative Assessments	Summative Assessments
In-class activities (think-pair-share) As we watch excerpts from the NATURE video, "The Volcano Watchers," write down examples of the attitudes of the people in the film towards volcanoes. Identify the attitudes that you found in the film with specific examples from Kellert's "Values of Life." Are there some values that we didn't observe in the film? Are there some attitudes that we observed which do not fit into one of Kellert's Values categories? Each group will be assigned **3** of the excerpts from "Parícutin, 1943," from the book Vulcan's Fury, by Alwyn Scarth. Match the description of the people's behavior in the reading with one or more of the "Values of Life" by Stephen Kellert. Briefly explain your choices and be prepared to report out. ***Lab activity on hazard mitigation and emergency planning*** Discuss with your group how the people in the area around your volcano are likely to respond to a possible volcanic eruption. Are people involved in a technological or traditional culture? Select **at least two (2) – or more** – of Kellert's values that represent the attitudes of the people around the volcano. In the space below, **explain** the values, attitudes, or behaviors that the people might have that you need to consider in communicating the volcanic risk. **Discuss** how people's attitudes and values might influence their ability to understand and be prepared for the volcanic hazards.	***Selected Response Question (in-class part of exam)*** The following items are examples of Kellert's "Values of Life." Match each value listed with the numbered statement that describes the behaviors of people living around a volcano. One letter will not be used. a) symbolic b) utilitarian c) naturalistic d) dominionistic e) theistic 1. People may sell volcano souvenirs or guide tourists around the volcano 2. People may resist evacuation, believing that the eruption will be "God's will" 3. People may want to try to divert lava flows and control the eruption 4. People may want to get close to the volcano and directly experience the eruption ***Essay Questions (take-home part of exam)*** Explain at least four (4) specific examples of the values that people find in volcanoes, using Kellert's "Values of Life." Give Kellert's name for the value and briefly state what kinds of human attitudes or behaviors the value relates to. Discuss one (1) specific example for EACH "Value" (4 examples total) of human attitudes towards and interactions with volcanoes. Your examples can come from the video excerpts (Iceland, Etna); from Mt St Helens; from Parícutin; or from another volcano. You may use more than one value from the same volcano. Be sure to cite your sources of information at the end of the essay. Discuss two (2) specific examples of how people's attitudes – their "Values of Life" – could affect their behavior in preparing for and experiencing a volcanic eruption. And discuss how understanding people's attitudes about a volcano – their "Values of Life" – can help disaster relief agencies plan for and cope with a volcanic eruption. In this course, we have explored people's attitudes towards nature and volcanoes (Kellert's "Values of Life"). We have explored the many ways that people perceive and respond to risks (volcanic hazards). We have tried to understand what it's like to make difficult decisions, with limited and ambiguous data – decisions that can have large consequences for people's lives. We have pondered what can happen when people do find – or do not find – "the will to act in the face of uncertainty," Voight (1988). Discuss in this essay what you have learned from these experiences in our class, and how you can apply these ideas and experiences in your own life.

easily relate to these as examples of symbolic language.

Activities and class discussion (Table 2) are intended to develop students' cognitive abilities to understand, apply, and analyze the values framework (in the sense of the revised Bloom's Taxonomy of Cognitive Objectives, Anderson and Krathwol, 2001). Multiple choice and essay exam questions in mid-semester assess this level of knowledge (Tables 2 and 3). Table 3 shows results from the same selected response questions asked in three successive years in terms of average percent correct (total n = 234 students); there are no systematic changes in any question from year to year. Results from the first essay question listed in Table 2 administered over two years are similar, with about 75% of the class receiving a score of 8.5 out of 10 points or more. We interpret these results to indicate that a large majority of students are able to understand and use Kellert's values terminology correctly and make correct distinctions among the values. A few specific examples from students' answers to the essay questions show their level of comprehension and their misconceptions.

> [full-credit answer] The **ecologistic/scientific** value is the systematic study of structure, function, and relationship in nature. Science is a discipline of questions, and a scientist always wants to answer those questions. Volcanoes' unpredictability causes many questions to be asked such as when will the next eruption be, what was the last eruption like, what kind of rocks were created by the magma, and what will happen next. While trying to solve these questions peoples' knowledge, understanding, and observational skills grow.

> [errors and misconceptions] The volcano became **symbolic** for the main reason of how long its occurred in the town. They've lived with it for so long it's become apart of their community. It helps provide heat for the town in the winter time and provides almost like a security for the town's people. [Correct values described by the student would be **humanistic** and **utilitarian**].

The values framework is brought into class later in the semester in a lab activity on emergency planning and volcanic hazard mitigation designed to build students' abilities to make decisions and act upon incomplete and uncertain information. Students work with "volcano scenarios" – hypothetical and somewhat simplified versions of actual volcanoes. Each scenario shows different types of infrastructure on a topographic map, such as large urban or suburban areas, small towns, or seasonal recreation areas. The lab activity questions (Table 2) ask students to work with the values framework in more cognitively sophisticated ways, as they must analyze and evaluate their volcano scenario, select appropriate values that represent the attitudes of their population(s), connect the values to risk communication strategies, and justify their interpretations. The lab activity questions are a formative assessment of students' ability to choose appropriate values and articulate their reasoning; examples include:

> [full-credit answer for scenario with major farming areas as infrastructure] "The people in this area will most likely be ***attached to the land***. They have large areas of major farming … a ***utilitarian value*** because [of] their use of the land for food… We might tell them that although they might have to evacuate the land a possible eruption might help crops in later years."

> [full-credit answer for scenario with coastal tourist hotels and fishing villages] "***Aesthetic, naturalistic, utilitarian values***… Hotel owners will want their business to continue and will most likely revolt against the evacuation plans…It seems like it is a close knit area of people because there are only 3 large towns so the people will want to stick together and probably not leave."

More fully-developed answers to a similar question are expected on a subsequent take-home essay (second essay question in Table 2). In the single year that this question was administered, 75% of the class received a score of 8.5 out of 10 points or more, indicating that they demonstrated the expected level of understanding of how people's values might influence their response to volcanic activity. Example of a full-credit answer:

> At the other end of the spectrum there is the theistic approach towards volcanoes. While this approach will most likely not underestimate the power of a volcano it does take some of the power out of the hands of the locals. The assumption that a volcano is a divine body and not subject to the laws of physics and nature is incorrect (and possibly lethal). If a local tribe simply assumes that whatever the volcano does is an act of

TABLE 3. RESULTS OF SELECTED RESPONSE QUESTIONS, 2007-09

Question	Correct Value	Mean and Standard Deviation
People may sell volcano souvenirs or guide tourists around the volcano	Utilitarian	85 ± 5%
People may resist evacuation, believing that the eruption will be "God's will"	Theistic	84 ± 6%
People may want to try to divert lava flows and control the eruption	Dominionistic	91 ± 2%
People may want to get close to the volcano and directly experience the eruption	Naturalistic	88 ± 3%

> god and that if they prey [sic] hard enough or respect the volcano no harm will come they could be putting themselves in great danger. …When disaster relief agencies are preparing for a volcanic eruption it is very important that they get a feel for the local attitude towards volcanoes. If the people are overly theistic about it the agency involved needs to try to educate the locals and explain the danger that they are in. If the local attitude is largely ecologistic it is important that the agency does not abuse the local trust in science and makes calculated and detailed observations and predictions.

In the last third of the course students read essays on the tragic destruction of the town and people of Armero, Colombia, by a lahar in 1985 (Voight, 1988). The deadly tangle of mistakes and missed opportunities led Voight (1988, p. 29) to conclude that, in the end, it was the "lack of will to act in the face of uncertainty." We believe that this is a profound insight into human behavior, not only with regard to natural hazards, but for all aspects of a largely unknowable future. People must make decisions with incomplete and imperfect information, and citizens in a democratic society must be willing to evaluate possible consequences and take a course of action. The volcanoes course provides students with multiple opportunities to practice this citizenship skill.

META-COGNITIVE REFLECTION ON THE VALUES FRAMEWORK

In both courses, students have an opportunity to reflect upon and internalize the values framework and thereby achieve a level of meta-cognitive knowledge (knowledge of self) that is an essential part of personal development.

In Humans and the Environment, students participate in a field trip to West Chester University's nearby Gordon Natural Area (GNA), a 100+ acre woodland. We walk for about 45 minutes along roads and trails, pausing several times to stand quietly, to talk and take note of what we can hear and see, and to attempt categorizing our responses using the values typology. After class the students write 300-400 word essays on what they learned which show that a short exposure to nature is enough to elicit authentic reflections on the values. One student's response:

> "During our walk through West Chester University's Gordon Natural Area I was able to examine exactly what I value about nature. Before the walk, I must say the dominionistic value was the most important to me… I would walk by a lawn and think that is beautiful, when all the grass was a uniform height and green… Although I still see this as a nice lawn I came to value other parts of nature… The aesthetic value is one that immediately made itself clear during the walk. When we would stop and keep silent, the awe that was inspired in me was a new feeling. I never realized how moving just being silent and present in a natural environment could be. Another value that I discovered was negativistic. I was constantly looking over my shoulder for a bear coming out of the woods, as silly as that may seem… I have always had the symbolic value, maybe because of my own religious background … I understood how some religions believed the trees "talked" as I heard the wind whisper through them. I learned the utilitarian value more when we walked through the Natural Area. Over time, people have become distant from the source of everything. At some level, most every product we use comes directly from something in nature. The walk through the natural area brought that, and the rest of the values, to the forefront of my mind. I learned to appreciate nature in a different way than before."

In Volcanoes, an essay question on the last exam asked students to express how working with the values framework deepens their understanding of human responses to the natural world and its hazards, and to reflect on the meaning of the values framework for their own lives (Table 2). In future, because it is almost impossible for the instructor to grade this essay question for "correctness," it will be assigned in a lower-risk format than an exam. Two examples drawn from some of the best essays illustrate students' deep level of understanding.

> I realized that although volcanic eruptions are beautiful and fascinating, devastation occurs and what makes the volcano hazardous relates directly to the people surrounding it, and the lives that could potentially be lost. … Whether it is specifically their home or the land surrounding it, Kellert's Values of life can almost always apply to them. … Trying to identify with these people, I have looked inside myself and have decided what my values of life really are and how I would react to having my life, as I know it, ripped away in front of me. I have seen that I have Naturalistic, Aesthetic, Symbolic and Humanistic values. … Without the knowledge that I have gained from this course, I would most likely … not take the warnings seriously until I would see the eruption myself because I would be in denial.

> Because this year was so horrific with natural disasters, I feel like I couldn't have taken this class at a better time. The things we learned about how to deal with the people, or how people deal with the situation they live in, were able to be used with all different types of disasters and different life situations. … I used to think that people that got hurt in volcanic eruptions had been hurt because they didn't know there was a volcano there… or they just did not have enough warning to get out of harm's way. … after this year, learning about how some people depend on volcanoes for their source of livelihood, and especially Kellert's Values of Life, I realized that it is really hard to tell people to get up and move, to leave their house and most of their belongings … I have found that these people, the ones that monitor the volcanoes, and those that live around it, have the "will to act in the face of uncertainty." … In time of uncertainty, they act

when they are needed, and they don't live in fear or in restriction do to this. I have discovered that this idea is exactly how anyone, even myself should look at life.

CONCLUSIONS

Environmental problems arise when the operations of the natural world and the expectations of the human world are incompatible. Thus, the root causes of environmental problems and their solutions need to be discussed in terms of both positive statements about the world and normative statements that express human valuation of the natural world. Introductory science courses best serve the needs of citizens when they provide an integrated understanding of environmental problems and of their origin and solutions. We propose that Kellert's Values of Nature provide a framework around which to develop such understanding.

We show that the values framework is applicable whether problems arise in the course of human 'action' (climate change, coal mining) or 'reaction' (coping with volcanic hazards). With practice and feedback students can learn the framework and then use it to better understand how their own, and others, valuation of nature contributes to solving problems. Key aspects of teaching with values are that:

1) The values are learned best when applied to substantial problems. Case studies should be used to provide a rich set of real-world situations or narratives.
2) Class and small group discussion monitored by the instructor and formative assignments are needed to clarify the values.
3) The values framework is useful for student reflection and meta-cognitive development. Summative assessments that ask students for personal reflections can be difficult to grade for "correctness."

REFERENCES

Anderson, L. W., & Krathwohl, D. R., eds., 2001, A taxonomy for learning, teaching and assessing: A revision of Bloom's Taxonomy of educational objectives, Complete edition, New York: Longman.

Bertog, Janet L., 2007, Student evaluation of cities' hazards and benefits for company relocation; an introductory geology class project in educated citizenship, Journal of Geoscience Education, vol. 55, p. 28-35.

Dessler, A.E., & Parsons, E.A., 2006, The science and politics of global climate change: A guide to the debate: Cambridge, Cambridge University Press, 190 p.

Dietz, T., Fitzgerald, A., & Shwom, R., 2005, Environmental values: Annual Review of Environmental Resources, vol. 30, pp. 335-372.

Friedman, T.L., 2008, Hot, flat, and crowded: Why we need a green revolution—and how it can renew America: New York, Farrar, Straus and Giroux, 438 p.

Kellert, S.R., 1993, The biological basis for human values of nature: in The Biophilia Hypothesis, S.R. Kellert & E.O. Wilson, eds., Washington, D.C., Island Press, pp. 42-69.

Kellert, S.R., 1996, The value of life: Biological diversity and human society: Washington, DC: Island Press, 263 p.

Minteer, B.A., & Collins, J.P., 2005, Ecological ethics: Building a new tool kit for ecologists and biodiversity managers: Conservation Biology, vol. 19, pp. 1803-1812.

Mordi, R., 1991, Attitudes toward wildlife in Botswana, 1991, New York: Garland Press.

Nie, M.A., 2002, Wolf recovery and management as value-based political conflict: Ethics, Place & Environment, vol. 5, pp. 65-71.

Palmer, Alison R., 1990, What should my neighbor know?, Geological Society of America News and Information, vol. 12, p. 10.

Pogue, Joseph Ezekiel, 1919, Geology as a basis of citizenship, Geological Society of America Bulletin, vol. 30, p. 77.

Scarth A., 2003, Vulcan's fury: Man against the volcano: New Haven, Yale University Press, 299 p.

Schwartz, S.H., & Bilsky, W., 1987, Toward a universal psychological structure of human values: Journal of Personality and Social Psychology, vol. 53, pp. 550-562.

Schwartz, S.H., & Bilsky, W., 1990, Toward a theory of the universal content and structure of values: extensions and cross-cultural replications: Journal of Personality and Social Psychology, vol. 58, pp. 878-891.

Voight, B., 1988, Countdown to catastrophe: Earth and Mineral Sciences, vol. 57, pp. 17-30.

Withgott, J., & Brennan, S., 2009, Essential environment: The science behind the stories, 3rd ed.: San Francisco, Pearson Benjamin Cummings, 400 p.