Using Drawings to Examine Teacher Candidates' Moral Reasoning About Climate Change[1]

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Abstract

We investigated prospective science educators' perspectives on climate change as a socioscientific issue. Using drawings as evidence, we focused on morality and ethics as dimensions of prospective teachers' environmental identity development. Participants (N=59) were undergraduate teacher candidates enrolled in a university-based Elementary Science Methods course. We present self-generated drawings reflecting teacher candidates' ideas about climate change causes and effects. We discuss our interpretations of the drawings, including the dimensions of climate change that appeared salient to participants, the ways in which participants appeared to represent emotions and behaviors, and the potential insights these aspects could provide into participants' moral reasoning about global climate change. In addition, we include data from two focal participants who engaged in follow-up interviews using their drawings as a referent. We found that despite the challenges of interpretation, drawings served as a fruitful tool for research on teacher candidates' perspectives related to climate change, as well as for teacher candidates' own self-reflection on a socioscientific issue with moral and ethical dimensions.

Keywords: teacher education, climate change, moral reasoning, socioscientific issues

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Introduction

Few would disagree that the climate change topic in the Next Generation Science Standards (NGSS Lead States, 2013) would benefit from additional educational research. As a new topic in U.S. science standards that some consider *sensitive* and that has direct societal implications, it fulfills the definitional criteria of being a socioscientific issue (SSI) (Zeidler & Keefer, 2003). At all points in their professional continuum—prospective to highly experienced—teachers of science need research-informed findings that apply to developing recommendations on how to teach climate change effectively.

In our experience as researchers of science teacher education, we have found that the use of participant-generated drawings regarding their thinking about multiple areas of interest is a productive strategy (Katz, McGinnis, Hestness, Riedinger, Marbach‐Ad, Dai, & Pease, 2011). Drawings are nonthreatening data sources for investigation of teacher candidates' thinking and do not take much time to generate in science methods courses. Combined with accompanying narrative summaries (augmented by follow-up interviews, at times, with some participants), offer an exceptional method for investigators to gain new insight into teacher candidates' thinking, including regarding their own roles in climate change education (Hestness, McGinnis, Riedinger, Marbach-Ad, 2011; McGinnis, Hestness, and Riedinger, 2011).

Since climate change is a recognized socioscientific issue, we focus our attention on using drawings to investigate the relatively unexplored moral and ethical stances that teacher candidates may hold regarding the topic. We hold the belief that such fundamental research is needed to inform those in teacher education who are involved with improving the preparation of teachers of science in climate change education. It is likely that for this new socioscientific issue

in the NGSS, teacher candidates will need to grapple with their own moral and ethical stances associated with climate change. Only through in-depth research will teacher educators, curriculum developers, and policymakers begin to understand what moral and ethical stances teacher candidates may hold on the topic, and how those stances potentially impact their decisions concerning implementation of the topic as recommended in the NGSS.

Our research question in this investigation was the following: *What potential insights might teacher candidates' drawings of the causes and effects of climate change (and accompanying written explanations) provide regarding their developing environmental identities, specifically their moral and ethical stances related to the issue*?

Literature Review

Environment, Morality, and Identity in Science Education

Environmental issues such as climate change can be characterized as socioscientific issues (SSIs), or open-ended, ill-structured, and unresolved societal problems with linkages to science (Sadler & Zeidler, 2004, 2005; Sadler, 2011, Zeidler & Keefer, 2003). In outlining a framework for socioscientific issues education, Zeidler, Sadler, Simmons, & Howes (2005) emphasized that science teaching and learning must include consideration of the moral and ethical dimensions of socioscientific issues, arguing that any view of scientific literacy "falls short of the mark if it ignores the fundamental factors aimed at promoting the personal cognitive *and moral* development of students" (p. 362, emphasis added). This argument supports a view that teachers of science must be aware of, and prepared to address, the moral and ethical dimensions of socioscientific issues such as global climate change. However, Forbes and Davis (2008) suggested that even when science teachers view the moral and ethical dimensions of science as important, they "may not view them as an equally important dimension of their

developing professional identity if not explicitly supported in teacher education programs" (p. 831). Here, Forbes and Davis appeared to suggest that moral and ethical development, particularly around socioscientific issues, may be an important element of identity development for teachers of science. Thus, the inclusion of socioscientific issues in science teacher education may be a promising practice.

Theorists outside of science education have likewise suggested connections between socioscientific issues (particularly environmental issues), morality, and identity. In the introduction to their edited volume, *Identity and the Natural Environment*, social psychologists Susan Clayton and Susan Opotow (2003) argued, "Because environmental problems are increasingly important, and because environmental issues appear to engage moral reasoning and beliefs in a unique and powerful way, we need a better understanding of the connection between environmental issues and identity" (p. 19). Toward this end, Clayton (2003) proposed *environmental identity*, or one's connectedness with the natural environment, as a dimension of identity development worthy of investigation. In her research with adults, Clayton found a correlation between environmental identity and environmental attitudes. She suggested that stronger environmental identity typically accompanies more ecocentric worldview, or, a tendency to see nature as having value beyond its value to humankind. In espousing particular environmental attitudes (e.g., ecocentrism vs. anthropocentrism), Clayton argued, individuals are allowed to express fundamental values and ethical standards.

Other researchers have elaborated on the notion of environmental identity, including its connections to affect and behavior. In their work examining children's environmental identities, Gebhard et al. (2003) noted that participants had a tendency to express their environmental values by anthropomorphizing nonhuman objects, such as trees. In doing so, they "evoke[d]

feelings of empathy for the object that permit[ted] it to be regarded as something worthy of moral consideration" (p.92). Here, Gebhard et al. highlighted the connections between affect (e.g. empathetic feelings), morality, and environmental identity. Further, Kempton and Holland (2003) suggested that identity plays a considerable role in determining environmental behavior. As individuals' identities form within a cultural world (e.g., the world of environmental action), they argued, that world becomes more salient. As this occurs, individuals may become more knowledgeable about and accountable for their actions within that world.

Science education researchers have examined identity development among teachers and learners of science, focusing on such areas as science identity (Carlone & Johnson, 2007), professional identity (Katz et al., 2011; 2013), and cultural identity (Aikenhead & Jegede, 1999) in science education. However, few have examined environmental identity—including its connections to moral and ethical development—in formal science education settings. A notable exception is Blatt's work (2013, 2014) examining environmental identity development among high school students. Blatt (2013) described varying ways that students viewed themselves in relation to the environment (e.g., as a part of nature, as damaging to nature, as superior to nature, as separate from nature, as a protector of nature). She noted in particular the tensions between high school students' developing environmental identities and their simultaneously forming consumer-materialist identities (Richins, 2004) or "the significance an individual assigns 'to the ownership of material goods in achieving major life goals'" (Blatt, 2014, p. 472). The interaction of participants' varying identities, including their family (social) identity, student identity, consumer-materialist identity, and environmental identity, Blatt argued, could create internal conflict for participants and impact their actions. Here, she drew on Gee's (2005) notion of the individual having multiple, potentially conflicting, socially-situated identities.

While the concept of environmental identity has not yet been applied to the study of science educators, it is possible that like learners, teachers may experience tensions—with implications for their teaching practice—as they contend with the interactions between varying identities (e.g., professional identity and environmental identity). Katz et al. (2013) suggested that the "continuous tension in the evolving identities" (p. 1359) of beginning teachers may lead them toward pedagogical actions they see as ensuring their job security (e.g., focusing on information delivery) over actions they see as exemplifying effective, reform-minded science teaching.

This may be an inauspicious sign for the teaching of socioscientific topics with moral and ethical dimensions, such as global climate change. As researchers of socioscientific issues education have reported, teachers may avoid teaching topics they perceive as potentially controversial, even if they view them as worthwhile (Cross & Price 1996; McGinnis & Simmons 1999; Sadler et al., 2006). Such discrepancies between teachers' beliefs and actions may, to some degree, relate to the experienced tensions between their identities. Therefore, we believe that extending the body of research on teacher identity to include environmental identity may have the potential to provide new insights into teacher thinking and practice around the teaching of socioscientific topics with moral and ethical dimensions.

Using Drawings to Gain Insight into Environmental Perspectives

For several decades, environmental and science education researchers have used drawings in diverse contexts to gain insight into learners' ideas about the environment and specific environmental topics. For example, Alerby (2000) engaged Swedish learners, ages 6 to 17, in a task that asked them to draw and verbally comment on what they thought about when they heard the word *environment.* Barraza (1999) evaluated English and Mexican children's

perceptions and concerns related to the environment by asking them to draw the Earth now and in the future. Bonnett and Williams (1998) embedded a drawing task within an interview protocol with adolescent students in the U.K. regarding their attitudes toward nature and the environment. Taking a constructivist perspective, Shepardson Wee, Priddy, and Harbor (2007) used drawings to analyze U.S. students' mental models of the environment. Each of these approaches provided insight into the use of drawings as a tool for eliciting learners' ideas about the environment.

Studies that have engaged learners in drawing about the environment have frequently accompanied drawing tasks with written or verbal explanation tasks. In some cases, these combinations of approaches have helped researchers to interpret participants' intended meanings. For example, Shepardson et al. (2007) based their protocol on White and Gunstone's (1992) *draw and explain* approach. Here, learners were asked to draw a picture of the environment and then explain their drawing in their own words. Shepardson et al. argued that this approach helped to provide insight into "the interest and intent of the student at that time… [and] what the student views as crucial or salient" (p. 331). Similarly, Alerby (2000) asked learners to verbally comment on their drawn responses to the question, *What do you think about when you hear the word environment?*. These types of studies suggested that drawing provided one means for students to reflect upon and express their ideas about the environment, and the act of explaining (verbally or in writing) provided an opportunity to reflect more deeply on their thinking. Together, these methods also helped researchers to gain greater insight into the ideas that learners hoped to communicate about the environment through their drawings.

In addition to providing insight into learners' ideas and thought processes related to environmental topics, drawings have also helped researchers to better understand how learners

see themselves in relation to the environment. Bonnett and Williams (1998) asked students to draw a picture of their favorite place, in order to examine participants' sense of connection to nature. In analyzing the drawings and accompanying interview responses, Bonnett and Williams were interested in how (or whether) students depicted natural places in their drawings. This approach suggested the potential efficacy of personally-relevant drawing prompts (e.g., "Draw your favorite…") for gaining insight into students' uniquely personal worldviews. In investigating learners' mental models of the environment through drawing, Shepardson et al. (2007) found that learners most often depicted the environment as a place where plants and animals live, but excluded evidence of humans (including themselves) or human activities. While to some degree, this may be related to the prompt given, it may also provide potential information about the ways in which learners see themselves, and humanity at large, as connected—or not connected—to the environment.

Research engaging learners in drawing has also provided insight into the affective dimensions of learners' thinking about the environment—particularly their worries or concerns about environmental problems. In analyzing children's drawings of the Earth now and in the future, Barraza (1999) found that more than one-third of the children depicted environmental problems, and more than half depicted a future decline in environmental well-being. Barraza interpreted from the drawings that "Children were worried and cared about the world. Some feared an uncertain future, others had a pessimistic view, and very few showed an optimistic outlook for the near future" (p. X). Based on these interpretations, Barraza argued that drawings could be a useful means of accessing information about the development of students' environmental perceptions, and called for further research on children's depictions of environmental problems. Likewise, through conversations with learners regarding their drawings

and other environmental images, researchers have noted the presence of concern and empathy, particularly regarding the welfare of animals (Alerby, 2000; Bonnett & Williams, 1998). In each of these studies, researchers also used drawings to interpret the extent to which learners appeared to hold more biocentric (i.e., valuing all living things) versus anthropocentric (i.e., valuing human interests) points of view.

Drawings have also provided researchers with insight into common themes or models that learners may share regarding the environment—particularly views that may be apparently positive or negative. In analyzing participants' drawings and comments about the environment, Alerby (2000) found that "the good world," or drawings depicting the environment as beautiful and clean (presumably positive characteristics), was the most common theme. In drawings categorized as representing "the bad world," learners expressed their ideas related to distant environmental problems, such as rainforest destruction. Within this category, Alerby noted variation in terms of learners' thoughts focused on "a 'now' perspective" (p. 217) versus more future-oriented thinking. Similarly, Shepardson et al. (2007) noted several common mental models of the environment that emerged in learners' drawings. In the most common model, students depicted the environment as a place where plants and animals live (similar to Alerby's "good world"). This suggests that human impacts on the environment may not have been salient features of students' thinking. Learners whose drawings fit into another model that depicted the environment as being impacted by human activity, may have viewed humans and human activities as more salient. Interestingly, this was most common with learners living in urban environments, where human impacts (presumably negative) on the natural world may be easily visible. These studies suggest that while learners are likely to have varied perspectives regarding environmental topics, drawings may provide a means of representing learners' ideas.

Summary

There is precedent in education research for using drawings to gain insight into learners' perspectives on the environment and environmental topics. Such studies have used drawings coupled with complementary research methods to gain insight into learners' thoughts and thought processes related the environment, their sense of connection to the environment, the affective dimensions of their ideas about the environment, and commonly held positive or negative views associated with the environment and human activities impacting the environment. Likewise, there is precedent in science teacher education research for examining teachers' identity development through drawing (Katz et al. 2011, 2013), though not with a specific focus on their environmental identity development or environmental values.

While none of the studies reported here was specifically focused on the moral or ethical dimensions of learners' thinking, they do provide a glimpse into this realm. Alerby's (2000) "the good world" and "the bad world" themes, for example, potentially allude to learners views of an idyllic environment as positive or right, or a degraded environment as negative or wrong. Barraza's drawings-based interpretations of learners' optimism or pessimism about our environmental future may also provide insight into the issues that learners may worry or care about. As these examples suggest, drawings as a research tool may have the potential to help learners to express—and researchers to better understand—the moral and ethical stances that learners take with regard to the environment and environmental problems. In applying this to pre-service teacher education, we sought to determine if the use of self-generated drawing would provide a method to elicit teacher candidates' moral and ethical perspectives on the environmental issue of climate change in a creative and non-threatening way.

Study Context

The course in which this study was conducted was a required 3-credit undergraduate science methods course in an elementary teacher education program at a major research university in the Mid-Atlantic. The enrolled teacher candidates were seniors. The course is one course of five different methods courses (language arts, mathematics, reading, science, and social studies) the teacher candidates take in the Fall semester, in addition to a 1-credit classroom management course. The course met one day a week for thirteen weeks for approximately two hours each class session, and the teacher candidates spent two full days a week in a professional development school. The authors of this study were the instructors of the course. The course has been the context of a series of investigations of pedagogical interventions (see McGinnis & Pearsall, 1998; McGinnis, 2003; Katz. et al. 2011, 2013; McGinnis et al., 2011, Hestness et al., 2011, and Hestness, McGinnis, & Breslyn, in press) with some recent investigations using drawing as a method to collect data.

Methods

Climate Change Drawing Activity

As an introductory in-class creative activity for a lesson on teaching sensitive topics in science education, teacher candidates in the elementary science methods course were asked individually to draw on a blank sheet of paper their image of the causes and effects of climate change[2]. The prompt was, *"In the space below, draw all that you know about the causes and effects of climate change. On the back of the sheet, write what you intended to communicate in*

[2] The selection of *climate change* as an example of an acknowledged socioscientific issue for the lesson was explained due to its presence in the recently released Next Generation Science Standards.

your drawings about the causes and effects of climate change." An analysis was performed of the 59 drawings that we collected.

Analysis of the drawings. Procedurally, three members of the research team individually examined the drawings and their accompanying written explanations to identify what was salient in the drawings pertaining to the prompt. After this application of open coding, the research team convened and shared information on each drawing. Informed by the literature on drawings and how others had made sense of what was represented in the drawings, our team then found it fruitful to make sense of our salient observations of the drawings by subdividing our observations in two categorical dimensions: affective and behavioral. The affective dimension was operationally defined as evidence we detected in the drawings in which we concurred depicted the teacher candidates' feelings of good or bad in regards to environment associated with the causes or consequences of climate change. We also included evidence in this category that we believed suggested insights into their feelings regarding optimism or pessimism or of an empathic disposition regarding life forms in the environment. The behavioral dimension was operationally defined as evidence we detected in the drawings in which we concurred depicted the teacher candidates' or other peoples' actions that impacted the environment negatively or positively, particularly as to how they were associated with the causes and consequences of climate change.

Interviews with Focal Participants

We selected two focal participants to interview as a way to gain greater insight into the potential of drawings as a method for expressing the moral and ethical dimensions of teacher candidates' environmental identities. Interviewees were selected based upon inferences we made during the initial coding process. We compiled a small subset of drawings that we interpreted as

most clearly representing aspects of the illustrators' moral and ethical stances. From this subset, we selected two focal participants who we believed to be expressing different kinds of environmental identities in their climate change drawings (i.e. one who we interpreted as potentially dismissive of climate change, and one who we interpreted as potentially concerned).

At the end of the class session in which they completed the drawings, one member of our research team conducted a one-on-one audiorecorded interview with each focal participant. Interviews lasted approximately 15 minutes each. During the interview, participants were asked to describe the causes and effects of climate change they chose to represent in their drawings. We then probed their thinking regarding how these causes and effects related to society, or the ways in which people contributed to or were affected by climate change. Finally, we asked explicitly whether the focal participants viewed these climate change causes and effects as moral or ethical issues, and to explain why they viewed (or did not view) them as such. We then transcribed the interviews and revisited each focal participant's drawing in light of the interview data, in order to develop assertions about the extent to which the drawings – and the process of discussing the drawings – allowed participants to express the moral and ethical dimensions of their environmental identities.

Insights

Climate Change Drawing Activity

The most salient representations in the teacher candidates' drawings (supported by their accompanying explanations) were the following: images of the earth's temperature rising due to increased energy (primarily from the sun) (see Appendix A, Drawings 1, 2); greenhouse gases being released in the atmosphere (primarily CO2, natural and human related) (Drawing 3, 4); melting ice (land and sea ice) (Drawings 2, 5); the ozone hole (Drawings 1, 6); dying animals

(Drawing 3, 5); pollution of the air and water (natural and human caused) (Drawing 2, 6); sea level rising (Drawings 1, 3); habitat destruction (Drawing 3, 7); and over-population of humans (Drawings 1, 4).

A secondary analysis of the drawing followed that focused on inferring the teacher candidates' feelings—our affective dimension. We found evidence of this dimension in the following depictions (and accompanying explanations). Teacher candidates showed in the environment animals, primarily solitary, penguins and polar bears with sad faces on melting sea ice (Drawings 8, 9, 10) and fish in the ocean with x's in their eyes (Drawing 5). One showed flowers that were dead. Another showed trees that were dead (Drawing 5). One showed a human in the winter with sweat on a frowning face (Drawing 11). Another showed humans with sad faces forced to leave their inundated homes (Drawing 8). They also had humans exclaiming explanations such as "There's too many of us! AAAAAAAAH!" (Drawing 7) and, "Too much radiation!" One intern drew a large sand time clock under a large sun and in explanation stated, "There are many causes of global climate change, some we control, but most we do not." (Drawing 12) These depictions suggested to us that the teacher candidates' were expressing unhappy, pessimistic feelings along with empathy, at times, for life forms being harmed in the environment. In contrast, a few showed in their drawings timelines and cycles of change that the teacher candidates wanted to represent as depicting the natural cooling and warming cycles of the planet – an optimistic perspective from how they perceive the condition of the current state of change in the climate (but not one supported by scientific data). As one intern stated in explanation of her drawing of a warm –cool cycle, "There have been incidents of cooling and warming periods in the past (Ice Age, Little Ice Age, Medieval Warming Period). Government/organizations take advantage of "human-caused global warming" for $." (Drawing

9) Another intern showed multiple causes of climate change including erupting volcanoes—labeled as "natural causes"—along with overcrowding of people, smoke stakes in industrial sites, and cars on a road. He commented in a somewhat guarded optimistic manner that, "The earth naturally fluctuates in temperature over thousands/millions of years, but humans are not exactly blameless either." (Drawing 4)

Our secondary analysis of the drawings also focused on identifying depictions of human actions that impact the environment and contributed to climate change—our behavioral dimension. Many teacher candidates drew cars with emissions coming from the tailpipes (Drawings 2, 3, 6, 9, 10, 11), smoke stacks (Drawings 3, 4), or factories that were burning fossil fuels (Drawings 2, 6, 7, 10, 12). A few drew depictions of deforestation and habitat destruction (Drawings 1, 3, 7, 10), overpopulation resulting in more pollution being released into the environment (Drawings 1, 4), and depictions of the ozone layer being diminished or an ozone hole growing larger (Drawings 1, 6). One explicitly made connection of urbanization, stating, "Urbanization also leads to the more CO2. The extra CO2 and other chemicals get trapped in the atmosphere and they trap heat in the atmosphere" to consequences of climate change (habitat destruction, more intense weather patterns, sea level rising, and economic issues) (Drawing 10). Others showed in their drawings money signs (Drawing 9), and they explained that human actions related to climate change had negative economic effects.

Interviews and Analysis of Two Focal Cases

Focal participant: Jill. Jill was an Asian American teacher candidate in her early 20s, who had transferred into our university's Elementary Education program after completing a two-year community college program. Figure 1 shows Jill's response to the drawing prompt, *"Draw all that you know about the causes and effects of global climate change."*

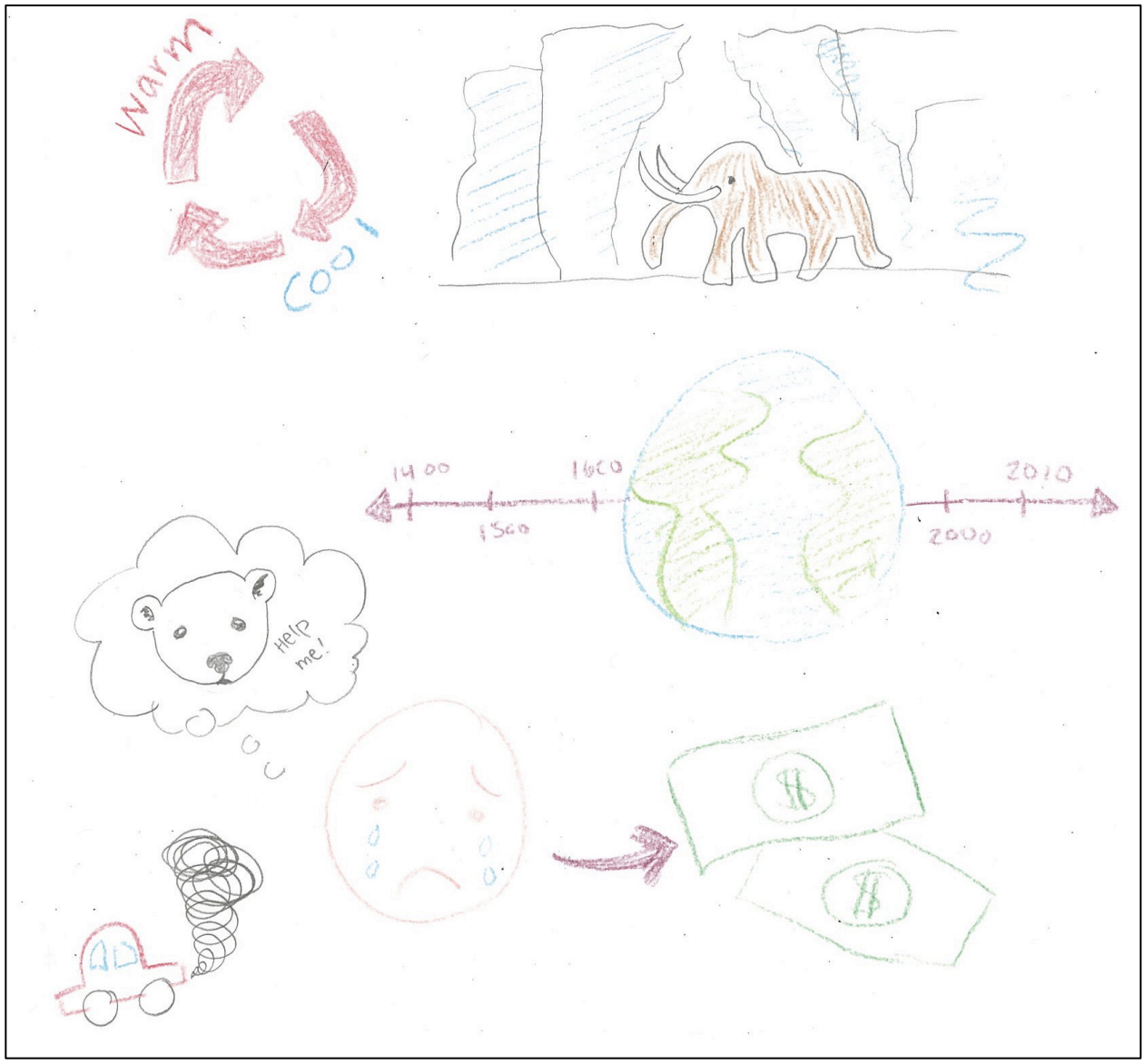

Figure 1. Jill's response to the prompt *"Draw all that you know about the causes and effects of global climate change."*

Initial drawing analysis. In our initial analysis of the salient features of Jill's drawing, we noted a number of key elements. Jill drew three arrows moving in a circle, labeled "warm" and "cool", which we interpreted to potentially indicate a natural cycle of climate conditions. She also drew a mastodon or woolly mammoth in front of a glacier or iceberg, and an image of planet

Earth on a timeline, with arrows pointing to before 1400 and after 2010. We interpreted this to indicate Jill's consideration of climate change as occurring over a long timespan, and potentially, as occurring in the absence of human activity. We were unsure about why she chose to begin the timeline with the year 1400, but we suspected that she may be depicting the Little Ice Age (~1350-1850)[3].

Regarding the affective dimensions of her drawing, we were struck by Jill's image of a person crying. Coming from the person's head was a thought bubble with an image of a polar bear inside it, and the words "Help me!" We believed this image to show some indication that Jill saw climate change as a potential threat to wildlife, and that this could be upsetting to people. Also coming from the image of the person crying was an arrow pointing to an image of money. While we interpreted this as potential evidence of her awareness of the connection between climate change and economics, we were unsure exactly what she was seeking to communicate. However, we saw both of these elements – the possible inclusion of wildlife endangerment and economic concerns – as potentially connecting in Jill's mind to moral and ethical dimensions of climate change. We interpreted only a small portion of Jill's drawing as linked with behavior: in the lower corner of the drawing, Jill drew a car emitting a dark cloud of exhaust. We interpreted this as Jill connecting climate change with the use of vehicles, though we were unsure whether she saw this as a moral or ethical issue.

Illustrator's commentary on the drawing. Jill's written commentary of her drawing helped provide some additional insight. Jill wrote that she intended to communicate the idea that "Earth goes through cool and warm cycles" and that "there have been incidents of cooling and

[3] An argument sometimes posited by those who do not believe that humans activities are enhancing global warming is that Earth is still coming out of the Little Ice Age http://www.skepticalscience.com/coming-out-of-little-ice-age.htm

warming periods in the past (Ice Age, Little Ice Age, Medieval Warming Period)". This description helped to confirm our interpretation of Jill's possible view of global warming as being independent of human activity, and therefore probably not an issue of moral or ethical concern.

With regard to Jill's drawing of the crying person and surrounding images (polar bear in peril, dollar signs), Jill wrote that "Government/organizations take advantage of 'human-caused global warming' for $". This statement helped to clarify Jill's intention and suggested that she did, indeed, see moral and ethical dimensions of the issue. However, her concerns were not related to the negative effects of a changing climate on wildlife or the economy, but instead, to the problem of the public being misled to believe that climate change is a problem. This dishonesty, she appears to believe, is leading people to donate money to government or (presumably) environmental organizations, to deal with a problem that does not exist. Her use of quotation marks around "human-caused global warming" suggest a view that these groups are possible lying to or "tak[ing] advantage" of the public for their own financial gain. We infer that Jill sees these actions as unethical.

Finally, Jill wrote, "Humans have little impact on Earth's climate, but they still pollute and cause damage to the environment" (Jill, written description of drawing). We interpreted this explanation to her drawing of the car emitting a cloud of exhaust. This statement suggested to us that Jill does see some connection between human activities and the wellbeing of the environment, which potentially suggests that she views human activities as decisions having ethical ramifications in terms of their potential effects for the natural world. However, she does not believe this is the case for the specific issue of climate change, since she views anthropogenic climate change as untrue.

Interview. When we interviewed Jill, using her drawing as a starting place, we gained greater insight still into Jill's thinking regarding climate change and its moral and ethical dimensions. In describing her drawing, Jill reiterated many of the same points as in her written explanation, adding the clarifying information that: "I have a picture of someone thinking of a sad polar bear saying 'Help me!' and an arrow going to money to represent how they might give donations to help the polar bears." (Jill, interview). This statement suggested to us that Jill may specifically see environmental organizations' use of charismatic megafauna to prompt concern (and donations) as manipulative or unethical.

Jill also stated that she "included a drawing of greenhouse gases from car exhaust." This statement was particularly interesting to us, as we had not interpreted greenhouse gases (or the greenhouse effect) as something salient to Jill in her thinking about climate change. This suggested to us a potential disconnect with her explanation that humans did not contribute to climate change. However, it could be the case that Jill simply connects greenhouse gases with pollution in general (which is cited frequently in the literature), and not with the greenhouse effect per se.

Jill felt that she did not have "very concrete scientific knowledge" (Jill, interview) about climate change. She explained that most of her ideas about the topic came from an Earth Science course she had taken as a community college student, before transferring to the teacher education program at our four-year institution. Regarding this experience, Jill stated:

> "My teacher was big on how humans did not cause the global warming, that that was a propaganda… we have an impact on the environment and can have negative side effects from greenhouse gases but we don't have enough power to change the entire climate and she says how there are cycles the earth goes through and… sometimes organizations or

> the government may take advantage of that and kind of get people to make donations and use that money... just a theory." (Jill, interview).

We interpreted her statement "just a theory" to potentially indicate her uncertainty about this explanation. While she may have been uncertain, since this explanation appeared to be the most well-developed one that she had heard, and came from a trusted source, it was the explanation she chose to depict in her drawing. If this was the case, this insight suggests that drawings may not fully capture the nuance of uncertainty as well as some other data collections (e.g., interviews) might.

When we asked Jill explicitly about whether she connected climate change – as she described the problem – with any moral or ethical issues. In response, Jill stated:

> "Yes definitely, if the government is realizing this and there isn't much human impact on the environment, then they are taking advantage of people's money and using people's sympathy for polar bears and basically lying to society, that is an ethical issue."

Here, Jill's use of an "If… then" construction suggested some uncertainty that was not as easily detected in her drawing or her written explanation. However, her drawing provided a concrete starting place and could serve as the basis of more elaborate explanations of her thinking – including regarding the moral and ethical aspects of the issue that she sought to communicate through drawing.

Focal participant: Melissa. Melissa was a White teacher candidate in her early 20s in her final year of our university's 4-year Elementary Education program. Figure 2 shows Melissa's response to the drawing prompt.

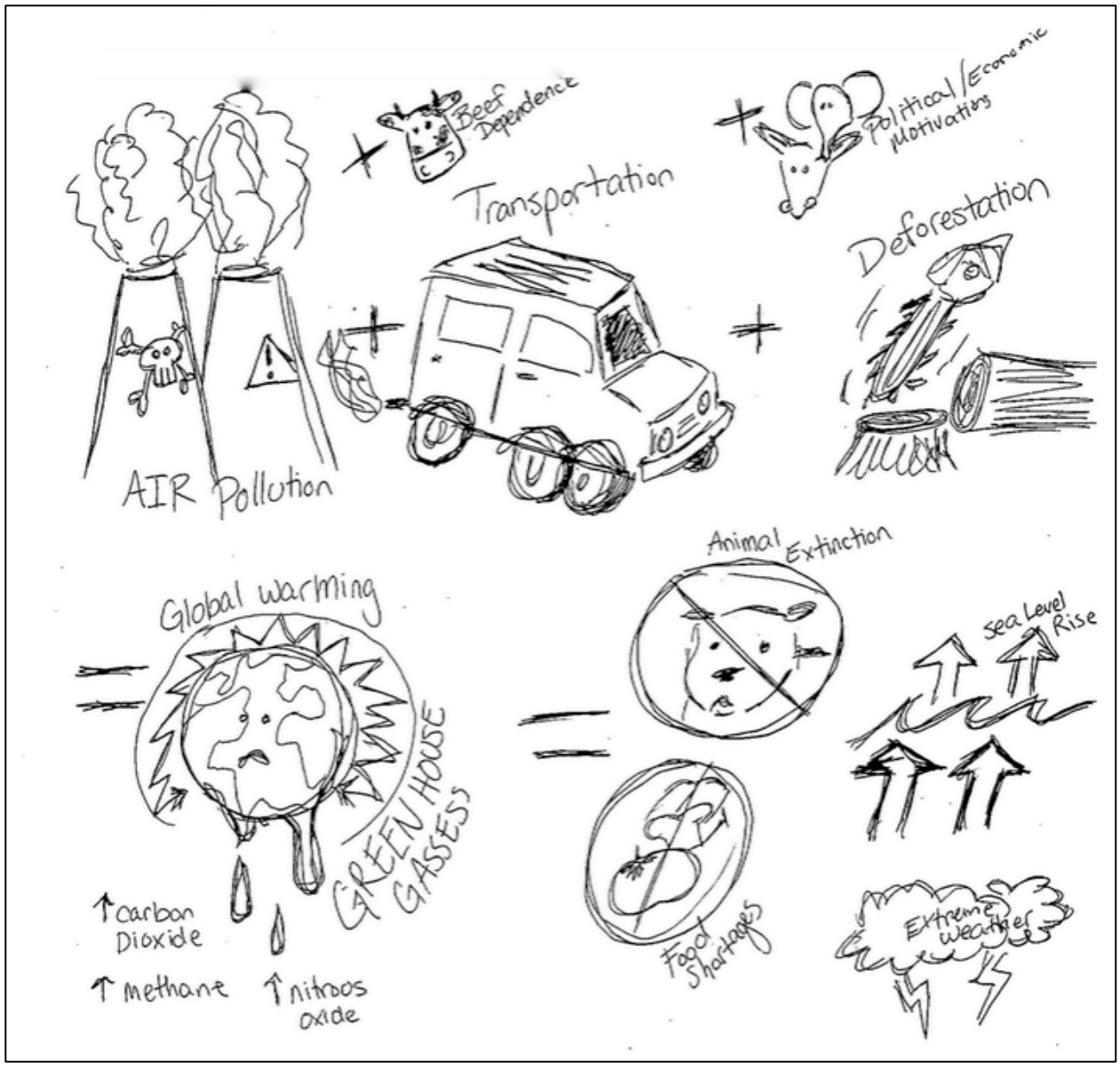

Figure 2. Jill's response to the prompt *"Draw all that you know about the causes and effects of global climate change."*

Initial drawing analysis. In our initial analysis of Melissa's drawing, we interpreted that she drew varying causes of climate change on the upper half of the page, and primary and secondary effects on the lower half of the page. Salient causes of climate change for Melissa appeared to include emissions from factories and vehicles, meat consumption, deforestation, and political and economic issues. We interpreted that together, these led to global warming

(represented by a melting Earth), which Melissa appeared to relate to increasing greenhouse gases. We further interpreted that Melissa saw global warming as leading to a variety of subsequent effects, including animal extinctions, food shortages, sea level rise, and extreme weather.

We noted several potential affective dimensions in Melissa's drawing, expressed through anthropomorphized elements of her illustration. She depicted the warming Earth with a frown, as well as a frowning polar bear—signifying that she saw these effects as undesirable, and potentially as moral and ethical issues, since human activities appeared to be involved in the causes. We were also interested in her inclusion of a donkey (symbol for the Democratic party in the U.S.) and an elephant (symbol for the Republican Party in the U.S), with the words "political/economic motivators". This suggested to us that Melissa saw climate change as a socioscientific issue—or as having a relationship to society, though it did not provide a clear depiction of her own stance on these political dimensions. In addition to these elements, we noted several of Melissa's ideas as being linked to human behavior. These included emissions from smoke stacks, a chainsaw cutting down a tree, a vehicle emitting gases, and production of beef. However, Melissa did not include any images of humans in her drawing, so it was unclear to us who she saw as responsible for these activities.

Illustrator's commentary on the drawing. Melissa did not provide a written description of what she intended to communicate in her drawing, so we asked her to provide a verbal description. In doing so, Melissa confirmed that she saw air pollution from factories and vehicles as an important contributor to climate change, as well as deforestation and meat production. In elaborating, she described the role of methane emissions from beef production and the loss of

forest as reducing the amount of carbon dioxide that could be stored on land—two ideas that were not evident to us in our initial interpretation of the drawing.

With regard to her inclusion of the political and economic dimensions of climate change, Melissa stated, "With a lot of the solutions to [climate change], …we know what the solutions could be, but there are political and economic reasons why we don't do those things" (Melissa, interview data). She also stated that she saw political and economic issues as both causes (e.g., inaction in mitigating the problem) of climate change and as effects of climate change (e.g., creation of political and economic tensions). We interpreted that inaction in the presence of known solutions might be an example of a moral and ethical concern for Melissa, but we would not have interpreted her idea about inaction on known solutions from her drawing alone.

Melissa's verbal commentary regarding the effects of climate change depicted in her drawing also added to our understanding of her thinking. In line with our initial interpretation, Melissa discussed her inclusion of animal extinction (especially polar bear habitat loss), sea level rise, extreme weather, and crop shortages. However, her commentary provided additional information about her thinking, including an awareness of some effects as locally relevant—including the impacts of sea level rise on nearby islands in the Chesapeake Bay. She also elaborated on her understanding of climate change and crop shortages (e.g., changing climate leading to increases in crop pests), though she did not appear to specifically frame food shortages as a moral (e.g., social justice) concern. Though she was highly conversant, and generally scientifically accurate, in her understanding of climate change causes and effects, her moral and ethical stances were somewhat difficult to clearly discern from her verbal description of her drawing.

Interview. During Melissa's interview, we asked her to discuss her drawing in terms of the connections she saw between society and the dimensions of climate change she depicted. Unlike Jill, Melissa stated that all of the causes she drew were influenced by human activities. She talked about humans meeting their own needs by using resources, such as fossil fuels and forests, "in excess" (Melissa, interview). While she did not explicitly state that she saw these actions as wrong, she did frame them in terms of choices that people make at individual and institutional levels, stating:

> "On an individual basis, you have do decide, am I going to buy this plastic thing, or am I going to use this reusable thing? For larger scale institutions like the beef industry or renewable energy, it's really a government issue, I think, and that goes back down to the individuals. Because if enough people are saying it, then the government is going to do it, but if not enough people are saying it, or there's not enough powerful people saying it, then nothing's going to happen, so it's very much a political issue, a government issue." (Melissa, interview)

Like Jill, Melissa appeared to believe that governments and organizations (or in Melissa's words, "special interest groups") played a role in climate change and decisions about climate change responses. However, Melissa appeared to take a more optimistic view that individual citizens could have influence with these institutions—with the caveat that powerful people must be involved, as opposed to Jill's view of institutions unethically taking advantage of or being dishonest with citizens.

When we asked Melissa directly whether she saw climate change as a moral issue, she stated that she did see it as such, and brought up the notion of values. She stated,

> "It's a matter of, I think, when it gets into the political and economic talk, it's a matter of what we value. Do we value, you know, transportation in our cars with gasoline, you know, over maybe not traveling as much and saving the Earth. Or do we value job creation, which goes a lot into the air pollution and factories... Do we value that higher than we value, again, the Earth? I think it's all a balance of whether we value what product we're getting… versus the benefits that it's gonna give the Earth." (Melissa, interview)

She spoke about her own decision to give up eating beef, both for environmental and health reasons. However, she did not identify as someone who was extremely concerned about climate change, ranking herself as a 6 on a scale of 1 to 10 (least to most concerned).

While Melissa saw climate change as a major environmental problem, she did not appear to consider it highly urgent, since she generally viewed the effects as not yet impacting society. For example, she saw the disappearance of polar bears, as well as sea level rise, as mostly future concerns. She did reference extreme weather events, such as Hurricane Sandy, as a counterexample of climate change effects having an impact now. However, she did not bring up moral or ethical issues in particular here, such as climate change effects having a differential impact on under-resourced communities.

Like Jill, Melissa shared that some of her information about climate change had come from university-based classes, particularly a plant sciences professor who integrated climate change and sustainability heavily into his course. She also stated that she had learned about the topic in her day-to-day life as a college student on our "very green conscious" campus (Melissa, interview). Outside of school, Melissa stated that she had watched *An Inconvenient Truth* with her mother, which was her first introduction to the topic of climate change. She stated that much

of her exposure to climate change, including its political dimensions, came from her family and her church, both of which she described as very politically liberal and engaged in environmental issues.

Discussion

Having examined teacher candidates' responses to the drawing activity, we return to our research question: *What potential insights might teacher candidates' drawings of the causes and effects of climate change (and accompanying written explanations) provide regarding their developing environmental identities, specifically their moral and ethical stances related to the issue*? Overall, we found that the use of drawings provided a tool for helping teacher candidates reflect on their understandings regarding climate change as a socioscientific issue. Further, the drawings provided us with insight into what participants knew about the causes and effects of climate change, and how they saw humans as involved. However, from the drawings alone, we found it challenging to make inferences regarding the illustrators' moral and ethical stances on these matters.

Through the drawings, we saw much potential evidence of the affective dimensions of teacher candidates views of climate change. As Gebhard et al. (2003) observed in their work with children, the teacher candidates in our study often used anthropomorphization to convey emotion. In most cases, we interpreted that participants included anthropomorphic features in their drawings to convey negative emotions—which may have been linked to environmental values, such as a view of Arctic habitat loss as problematic or wrong. This was consistent with Barraza's (1999) finding that drawings about environmental issues often suggested a pessimistic outlook or worries on the part of the illustrator.

In a few instances, we found that participants' depictions of emotional features in the drawings was misleading when checked against written descriptions of what they intended to convey. For example, one participant depicted a smiling fish in her drawing, but clarified in the written description that aquatic life forms were dying as a result of climate change. This was one of various instances where we saw the inclusion of the written component as essential for interpreting the illustrator's meaning, in line with White & Gunstone's (1992) *draw and explain* approach. Similarly, when focal participant Jill depicted emotion in her drawing, (a person crying – see Figure 1) her written explanation and interview revealed that she did not see the emotion she was conveying as genuine—that people might overdramatize climate change for personal or political gain. This level of nuance was not possible for us to interpret from the drawing alone, though Jill's written explanation and interview were helpful in providing additional insight.

In examining the drawings, we were likewise challenged to interpret how teacher candidates saw themselves in relation to climate change, or more broadly, in relation to the natural environment (Clayton, 2003). None of the participants included themselves in their drawings, and few included images of people at all. It is possible that participants fell into the type of environmental identity category that Blatt (2013) described, as viewing themselves as separate from nature, and therefore not including themselves in the context of an environmental issue. Alternately, the absence of people—including oneself—may be an artifact of the drawing prompt, which did not explicitly ask participants to draw themselves in relation to the issue of climate change. To gain greater insight into how teacher candidates personally identified with the topic, it may be beneficial to use a drawing prompt that explicitly asks the illustrator to include themselves in the drawings (as modeled in Katz et al.'s, 2011, 2013 investigations of teacher

identity development through drawings) or to draw a personally relevant aspect of the issue (as modeled by Bonnet & Williams, 1998).

Despite the challenges of interpreting how participants saw themselves in relation to the issue of climate change, we did note potential evidence of participants' awareness of the tension between environmental and consumer-materialist ideals (Blatt, 2013) or ecocentric and anthropocentric worldviews (Clayton, 2003). That is, in depicting the role of human activities as a dimension of climate change, we noted the frequent co-presence of damaging consumptive activities (air pollution from factories, vehicle emissions) and negative environmental consequences, similar to "the bad world" (degraded environment) that Alerby (2000) described. Whether participants saw these as moral problems was difficult to interpret in the absence of greater conversation about their intended messages. However, this finding did suggest that these tensions were potentially salient to participants.

Related to this, we were able to make interpretations regarding how participants saw human activities as related to climate change. A majority of participants included human actions such as fossil fuel combustion or deforestation as related to climate change. However, we were unable to interpret from the drawings alone how – or whether – participants saw their own activities as relevant. By interviewing focal participants about their drawings, we saw examples of how this information could emerge. For example, when Melissa discussed the inclusion of beef production in her drawing, she elaborated on her own decision not to eat beef. This example suggested to us that the illustrator's inclusion of certain features may have underlying connections to their environmental actions, and thus, their environmental identities. The process of discussing drawings, then, may provide a useful forum for understanding personal reasons for the illustrator's inclusion of certain features.

In summary, the use of drawings as a tool for examining prospective teachers' moral and ethical stances related to climate change assisted us in gaining insight into some dimensions of their thinking. It also raised new questions regarding the relationship between participants' moral and ethical perspectives and their personal environmental identities. Further, we wonder how these environmental identities have the potential to interact with participants' developing professional identities as teachers of science responsible for including socioscientific issues, such as global climate change, in their future teaching practice.

Limitations

While the use of self-generated drawings to reveal insights into the drawers thinking and beliefs has an extensive history, we acknowledge a major limitation of its use. Of major concern is the validity of the inferences made by viewers of the drawings. To address this concern, we asked all the drawers in our study to write out on the back of the sheets on which the drawings were made what they wished the viewer to see in the drawing. In addition, for our focal case study participants, we engaged in one-on-interviews in which we asked them to describe what they drew and what it meant to them.

Conclusions

Oftentimes the teaching of science is portrayed to prospective teachers and others as a series of practices that project a view of teaching about nature that emphasizes rationality to the exclusion of a concern for morality and ethics. In our experience, considering prospective teachers' thinking about personal and societal responsibility regarding socioscientific issues such as climate change is necessary. It provides a more holistic understanding of their developing identities. This is particularly true when the focus is the environment and the topic is one that many teacher candidates consider a sensitive topic due to how it is presented and perceived in the

United States. The use of self-generated drawings has been essential in our quest to collect meaningful data that can be used to interpret how teacher candidates make sense of the climate change topic and their future roles as educators. As a result, we recommend highly the drawing method to other researchers in science teacher education who are engaged in research on climate change education.

Acknowledgements

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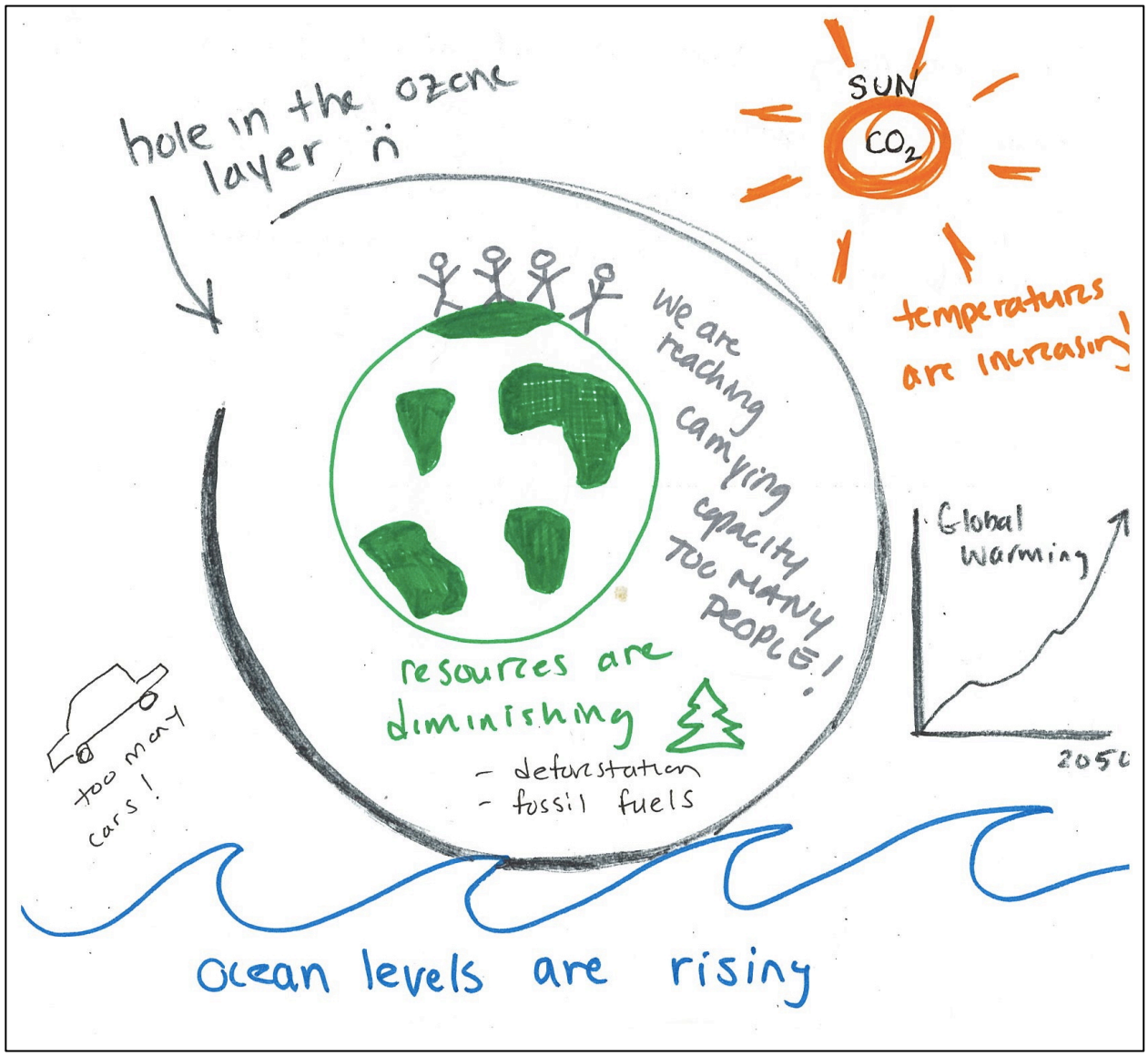
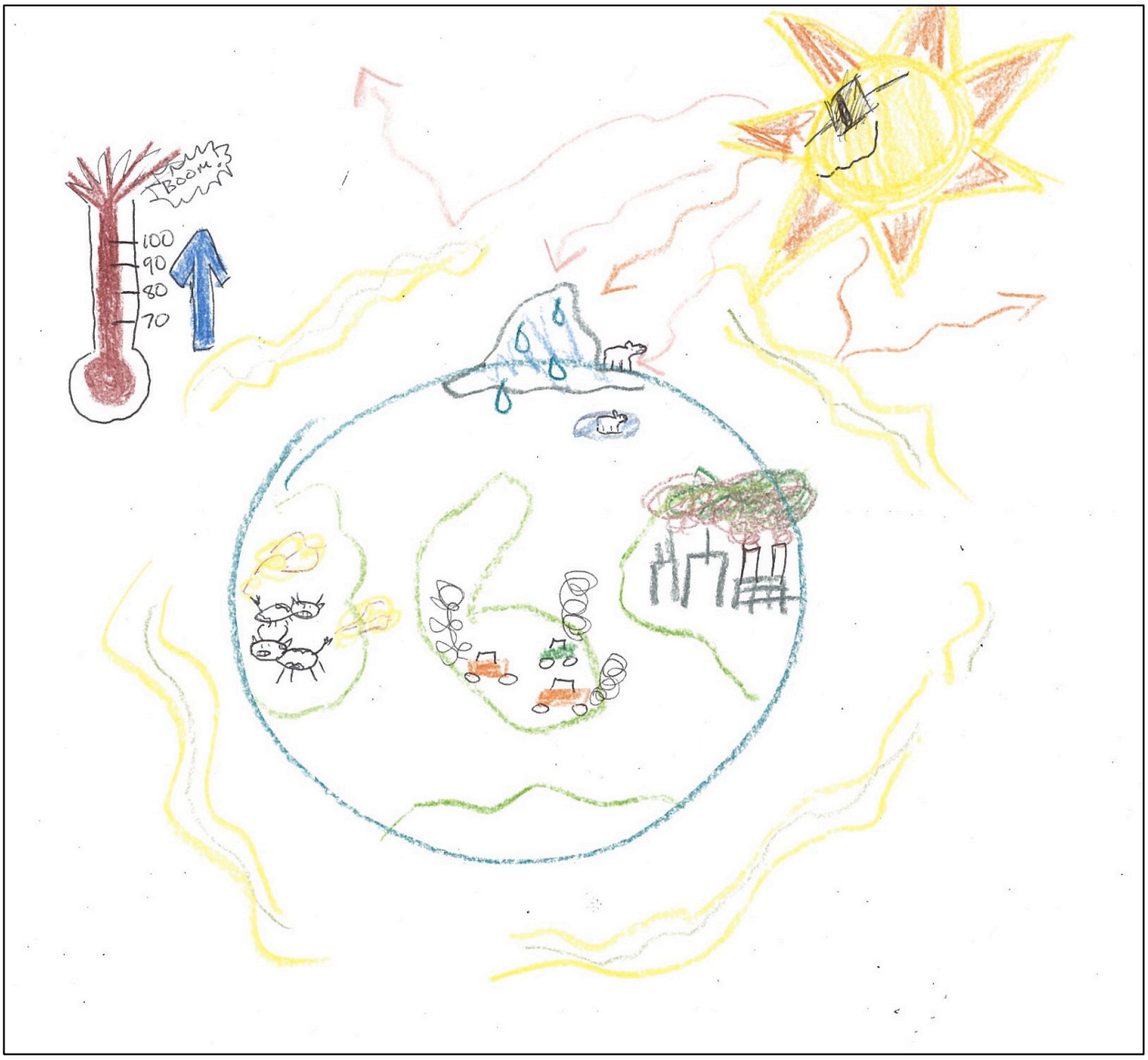
APPENDIX A

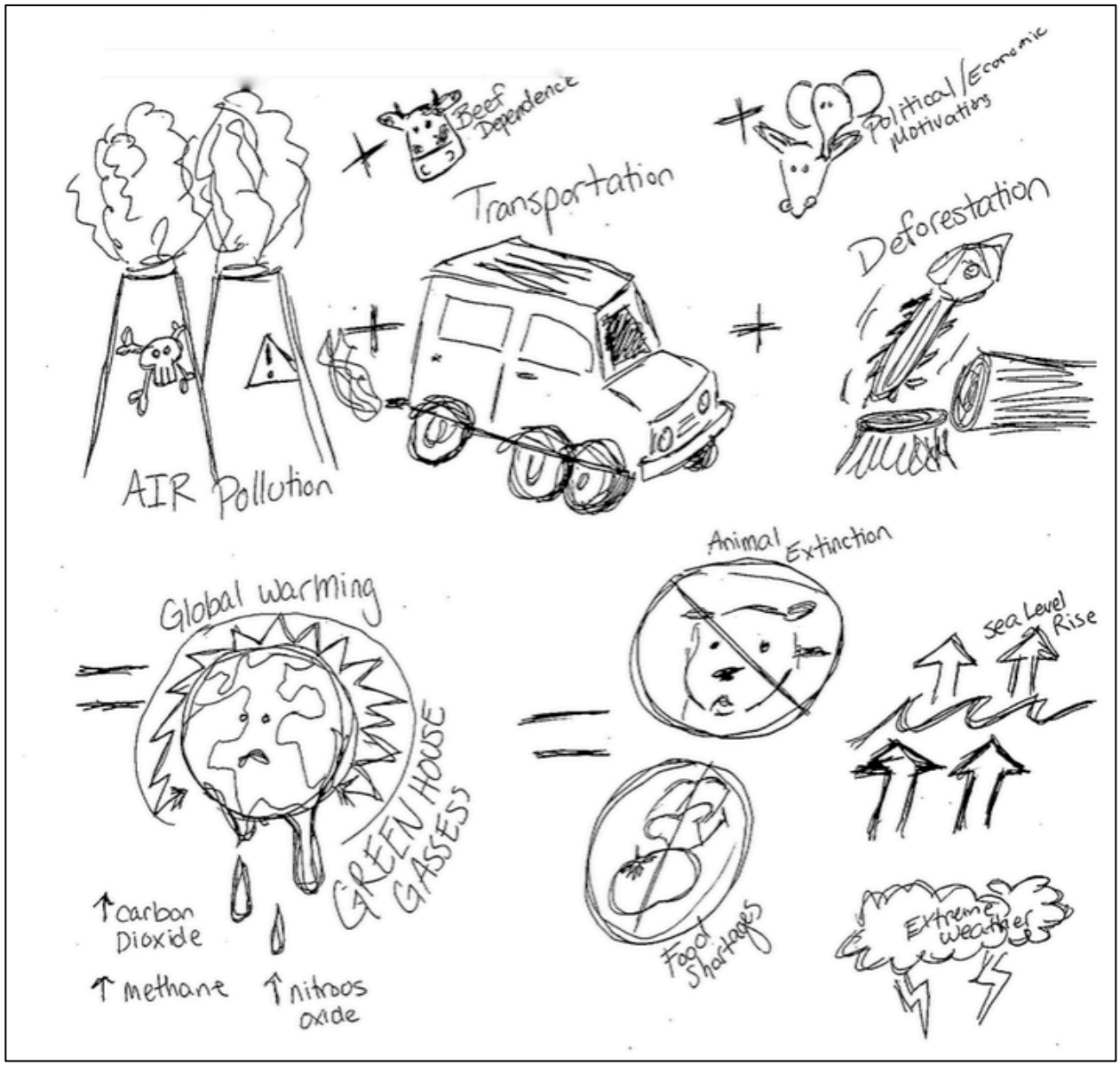
Drawing 1



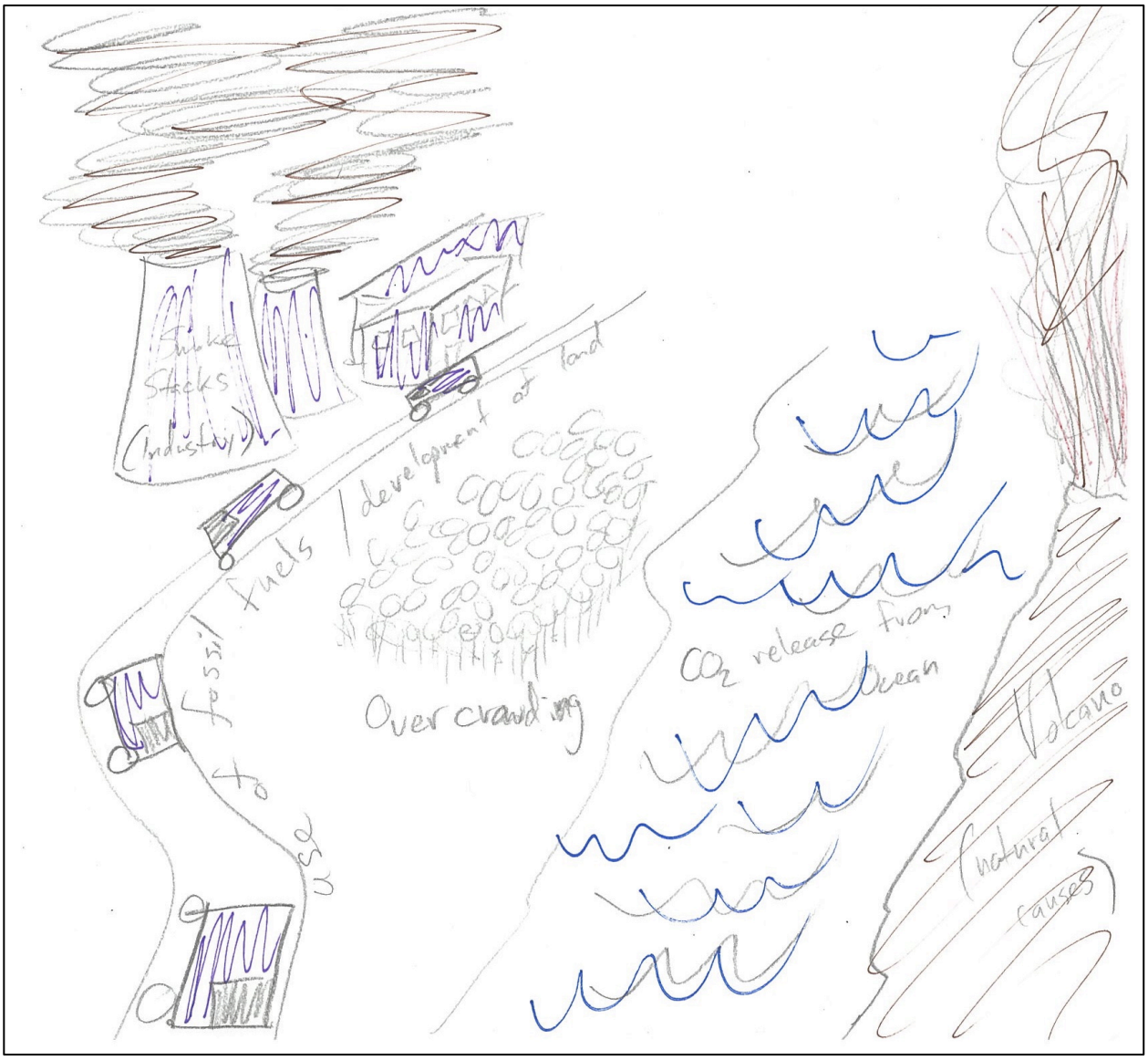
Drawing 2



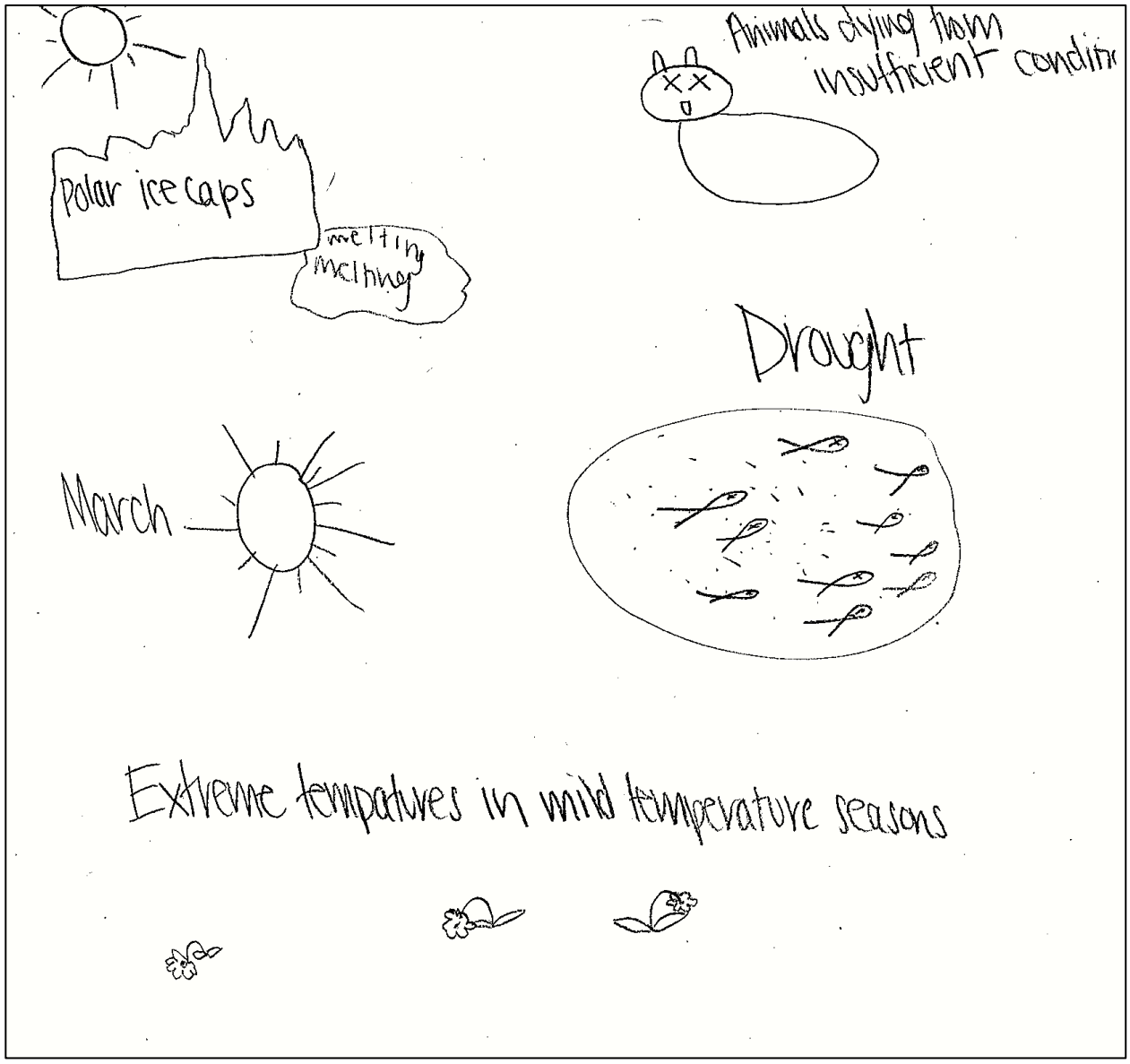
Drawing 3 – Focal Participant Melissa



Drawing 4

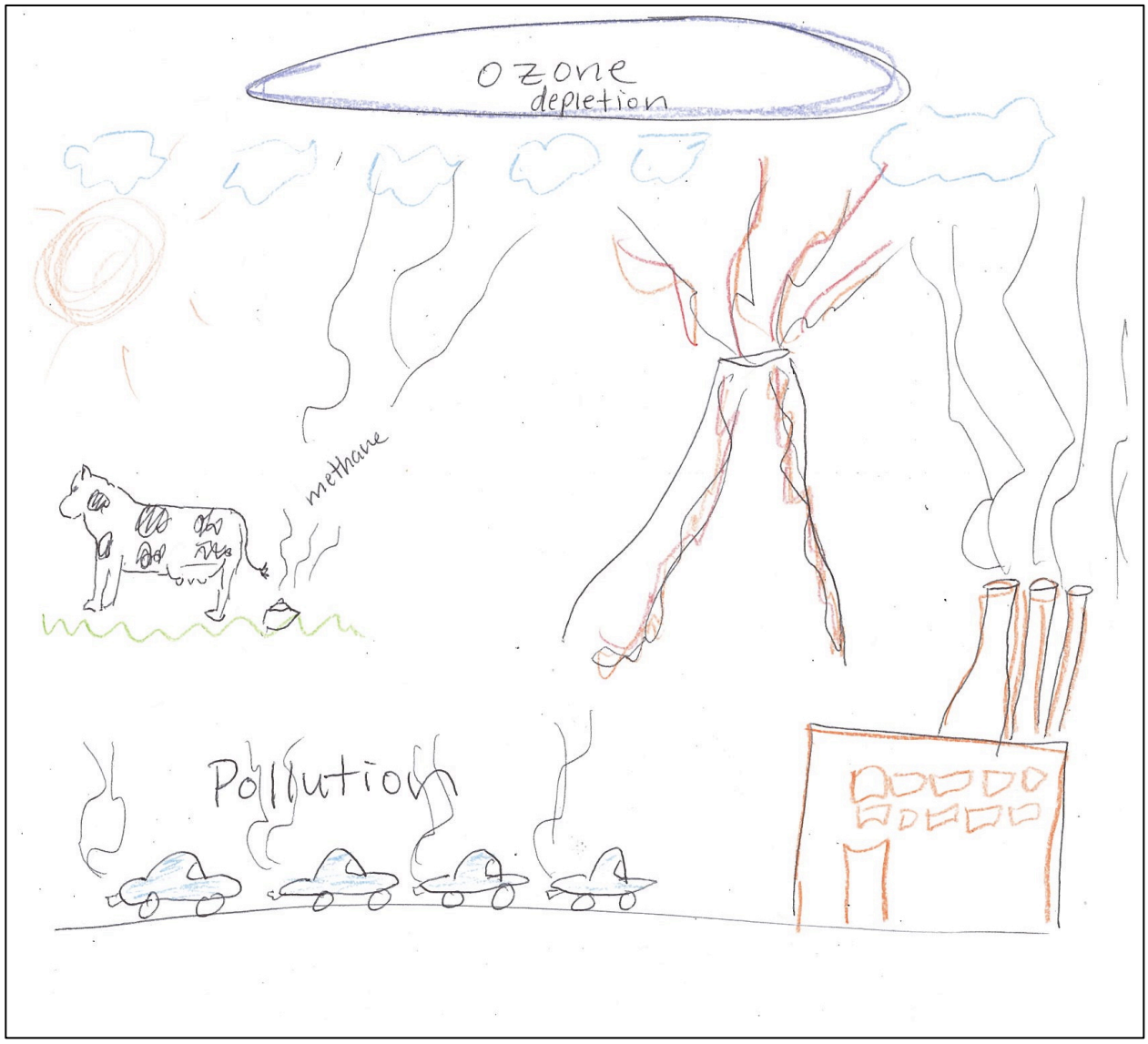

Smoke stacks (Industry)
development of land
Fossil fuels
Over crowding
CO_2 release from ocean
Volcano
(natural causes)

Drawing 5

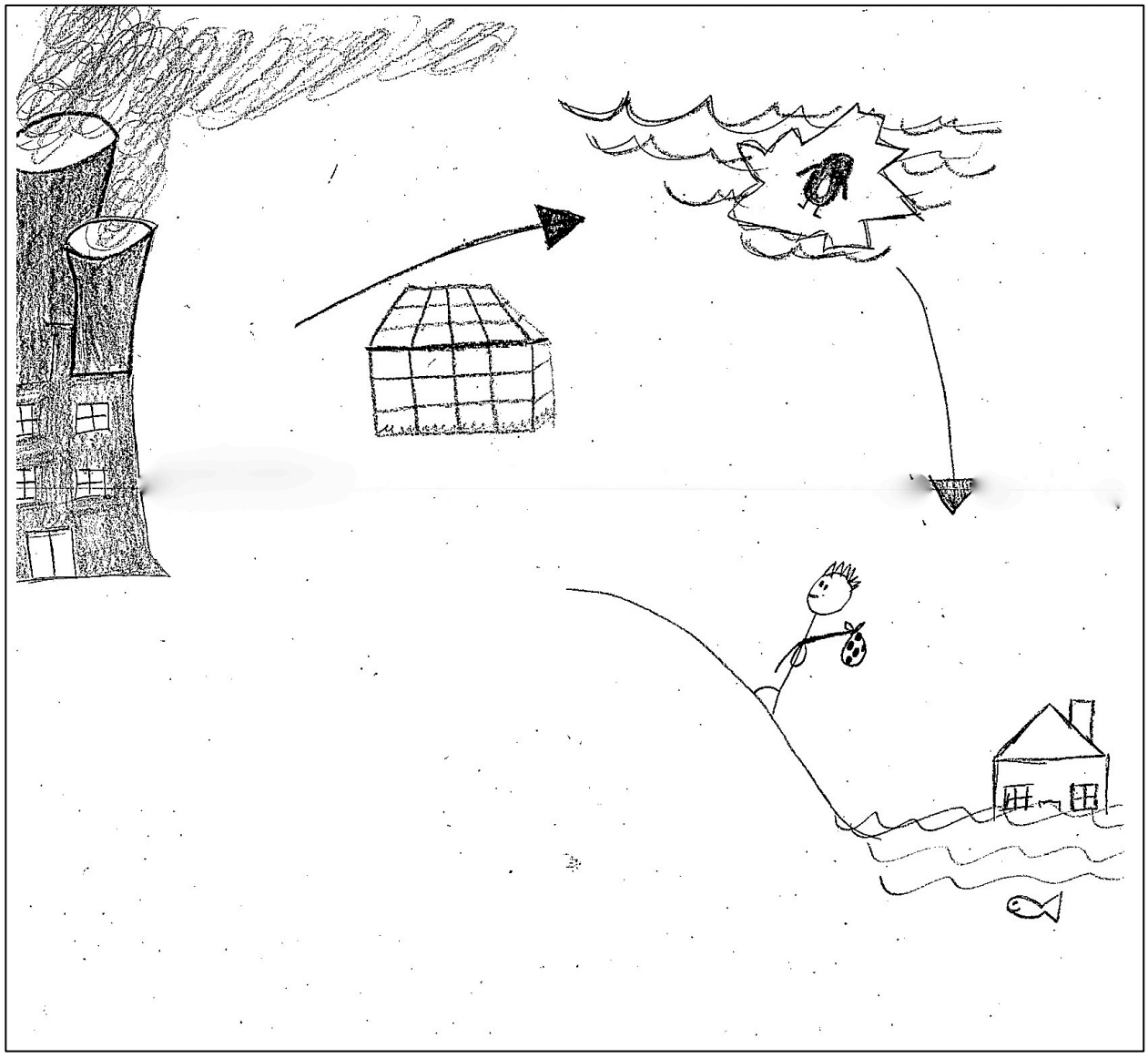

Animals dying from insufficient condit
polar ice caps
melting
melting
Draught
March
Extreme temperatures in mild temperature seasons

Drawing 6

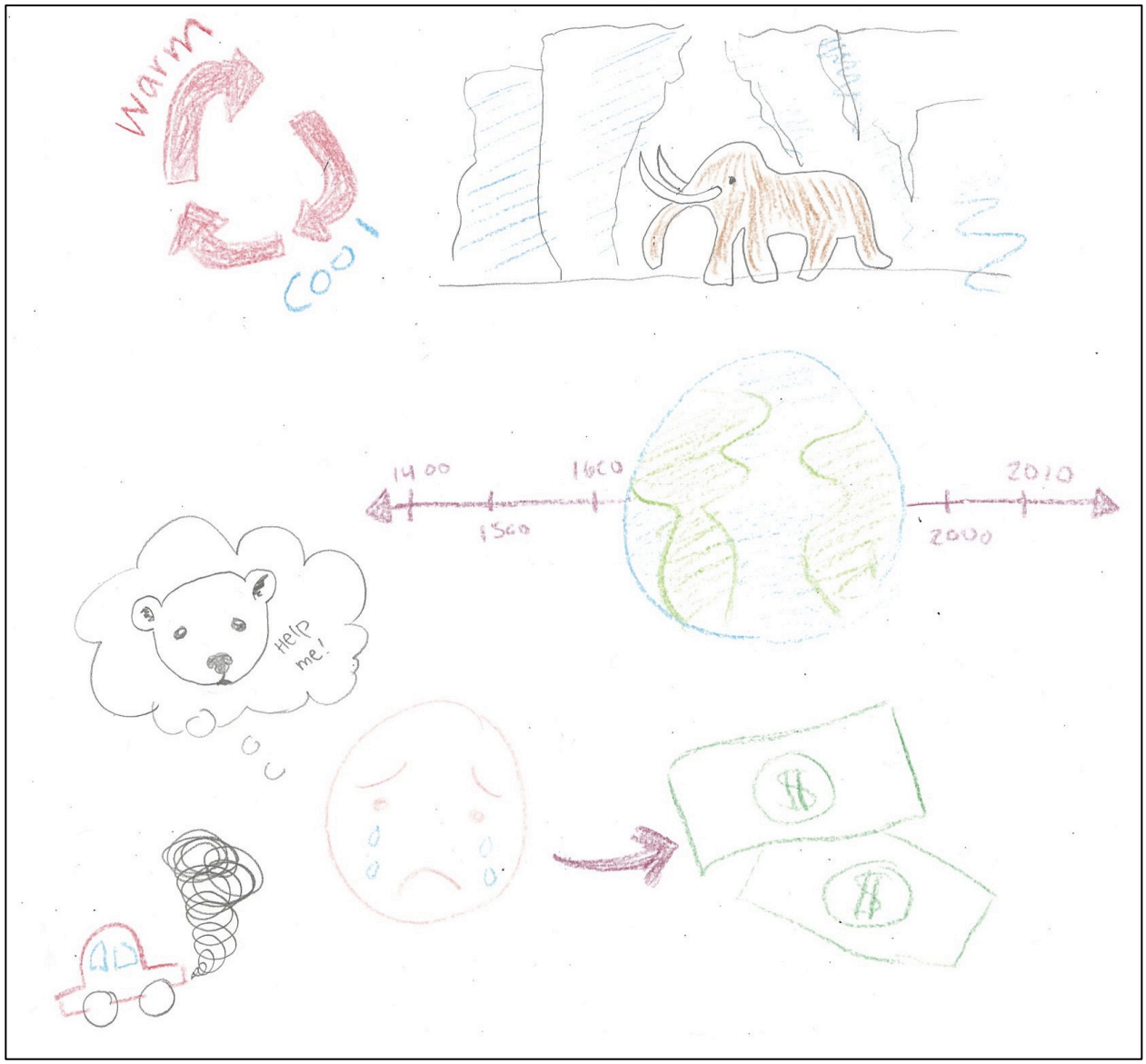
Drawing 7



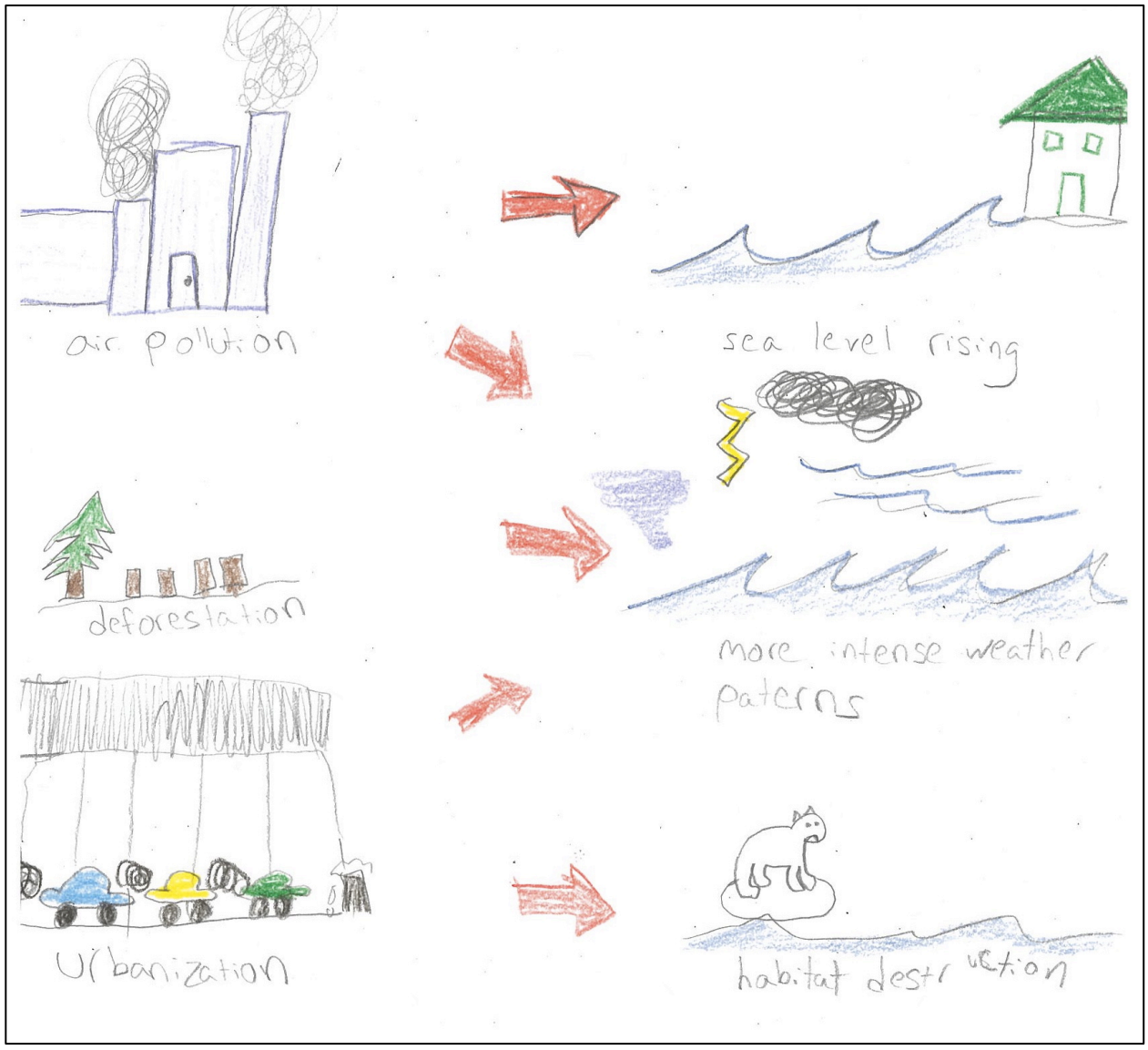
Drawing 8



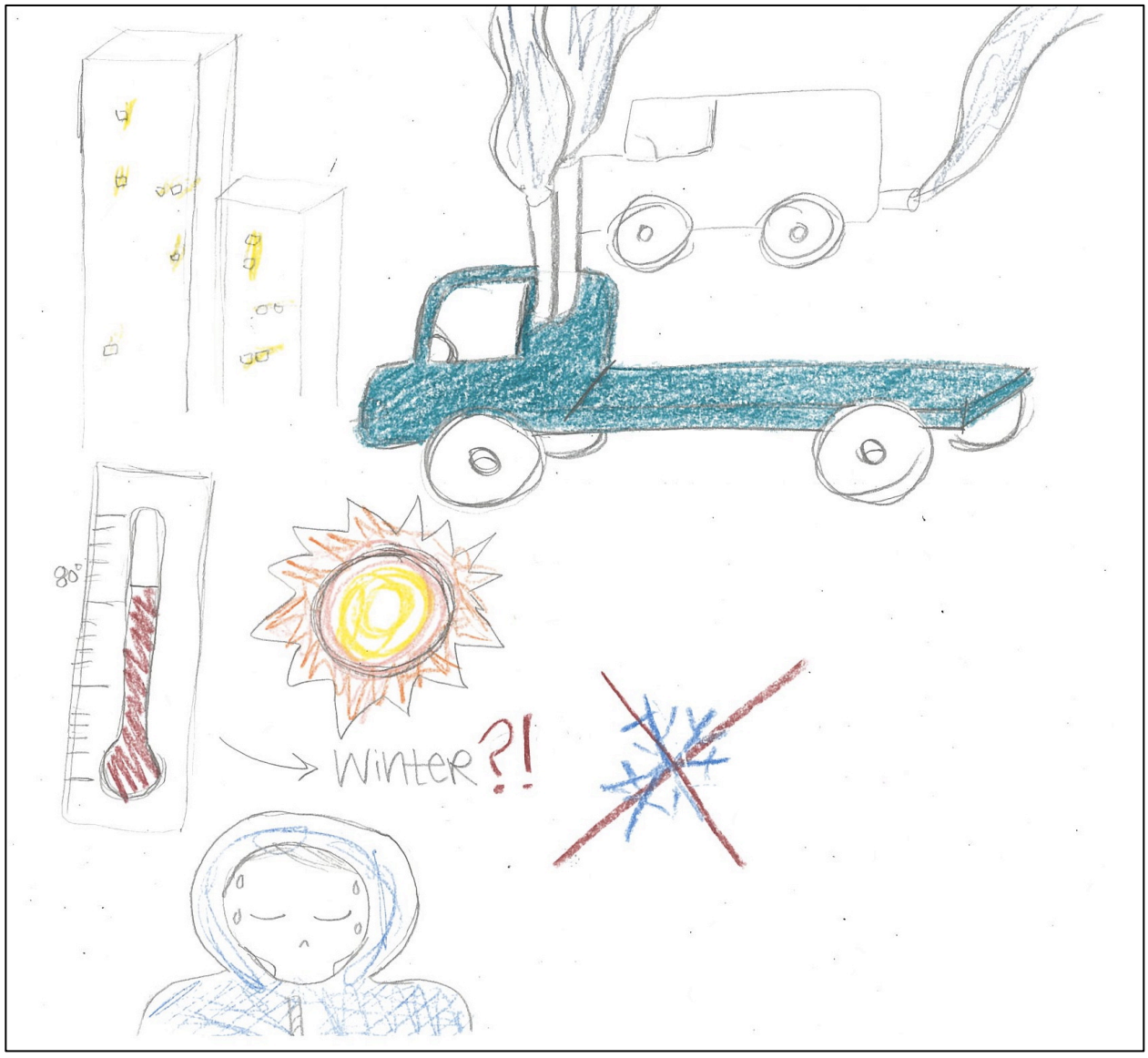
Drawing 9 – Focal Participant Jill



Drawing 10


air pollution
sea level rising
deforestation
more intense weather paterns
Urbanization
habitat destruction

Drawing 11



Drawing 12