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How Could We Be So Ignorant About The Visible Impacts of Climate Change? History of Air Pollution, Hıman Response and Educational Efforts

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Abstract

How could we be so ignorant on our responsibilities about the visible impacts of climate change? The answer is easy but hard to interpret; current education system does not let us do to so. With this review, I attempted to interpret the answer of this question through the history of air pollution events in correlation with human response and educational efforts. The story begins in the 13th century and expands with the attempts to develop an education system for a brighter and sustainable future.

Keywords: *Climate change, education for sustainable development, climate change education*

Introduction

We aware since Tbilisi Declaration (UNESCO, 1977) that, science and technology can no doubt provide solutions to environmental problems, which probably helped to cause, nevertheless, solutions sought should not be short-term ones nor too narrowly conceived. Solutions, on the other hand, have to take into account social and cultural factors which are so often at the root of environmental problems. What is necessary is a close examination of the complex relationships between people and their environment. The equilibrium in the flow of matter and energy through natural ecosystems as well as ecosystems already modified by humanity must be re-established. In addition, models of economic growth, development, environment and culture must be reconsidered. It has become essential to look-over the lifestyles to distinguish between the essentials

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and luxuries for both the environment and development. This is one of the bases to advocate a holistic approach to the management of environmental problems. Therefore, the recognition of reasons, results and implications of environmental problems must be coupled with an increasing awareness of solidarity among nations. Improved management of the environment should aim reducing existed disparities as pertaining sustainable use of natural resources and bringing about international relations based on equity. Environmental Education (EE), therefore, has an evident role to play if the issues are to be grasped and if all concerned are to be provided with the knowledge, skills, and attitudes to modify the existing situation for the better. Building on more than 30 years of experience in environmental education, education for sustainable development (ESD) continues to highlight the importance of addressing the issues of natural resources as part of the broader agenda of sustainable development. In December 2002, the United Nations General Assembly (UNGA) adopted resolution (57/254) to put in place a United Nations Decade of Education for Sustainable Development (DESD), spanning from 2005 to 2014.

Teaching society, about how to behave responsibly, towards the environment lies at the core of ESD. The founding value of ESD is respect; respect for others and respect for the planet and what it provided us with. ESD wants to challenge us all to adopt new behaviours and practices to secure our future, seeks to integrate the principles, values, and practices of sustainable development into all aspects of education, in order to address the social, economic, cultural and environmental problems we face in the 21st century. Climate change is one of the themes of environmental perspectives of the ESD. Educating about climate change builds the skills and attitudes needed to question the way we think, the values we hold and the decisions we make in the context of sustainable development. Improving awareness about the sustainability involves issues like the impact of human activities on earth systems, control of greenhouse gases, land and energy use, consumption patterns, pollution and transport. ESD for climate change can be appreciated as one of the powered tools for climate change adaptation and mitigation since it offers innovative ways of framing to make sense in people's daily lives and of translating passive awareness into active concern and behaviour change. ESD for climate change has been covered in several researches all over

the world the major areas of focus being, problems on the implementation of EE, misconceptions of both teachers and students especially related to global warming and ozone layer depletion issues, attitudes towards climate change problems and solutions and environmental literacy components and environmental responsible behaviour (Cutter, 2002; Dove, 1996; Gayford, 2000; Michail, Stamou & Stamou, 2007; Özdemir & Çobanoğlu, 2008; Summers, Kruger, Childs & Mant, 2000). The researchers also interested in the regional differences in students' and citizens' attitudes and behaviours toward environmental pollution issues as a whole. According to Bangay and Blum (2010), for example, increasing attention to climate change and the current global economic crisis has underscored the need for approaches to climate change education. But, although there are a range of educational and research initiatives already exist, policy and discussion continue to focus on technical solutions or 'knowledge transfer' without seriously engaging with the content of education. Moreover, as reported by Tarabini (2010), the global development agenda attributes a key role to education in the fight against poverty, which is one of the major issues in tacking climate change. What is more, Mason (2009) considers the challenge of sustainable change and development in education from the perspective of complexity theory. According to him, complexity theory's concept of emergence implies new properties and behaviors emerge that are not necessarily contained in the essence of the constituent elements, or easily able to be predicted from knowledge of initial conditions in the case of a significant degree of complexity in a particular environment. Therefore, the common idea is that, education has not given the value it deserves in the climate change adaptation and mitigation agenda. The main idea of this manuscript therefore, is to present a thematic review of education for the adaptation and mitigation for global climate change problem by means of emphasizing how ignorant is the human being toward the problem in the past and in the current time.

Action and Response

From hunter gatherers to ozone layer depletion

"Hunter-gatherers live in the forest; agriculturalists live adjacent to but within striking distance of the forest, and urban-industrial men live away from the forest. Paradoxically, the more the spatial separation from the forest the greater the impact on its ecology, and the further removed the

actors from the consequences of this impact!" (Gadgil & Guha, 1992, p.67)

Earliest probable evidence of fire used deliberately to clear forests in the Kalambo Falls site in Tanzania points out 60,000 years before present (Grove, 1995). Air pollution is concurred with the appearance of humans, continues to grow and as we stand still unconsciously, it will continue to intrude the life on Earth. Signals are clear and actually there are number of evidences for air pollution beginning from ancient civilizations that should not be disregarded:

When Homo sapiens first lighted fire, its smoke provided the first medium of environmental pollution. Most of the lungs of mummified bodies from the Palaeolithic have a black tone. In the first inhabited areas smoke was not driven away (one of the practical reasons might have been protection against mosquitoes) and the people dwelling in these inner areas found shelter in the smoke (McNeill, 2001). Humans, on the other hand, seem to have been living together with this unhealthy form of air pollution for many thousands of years. In the 21st century, in spite of all the educational attempts, we are still ignorant on our responsibilities about the visible impacts of air pollution and especially climate change.

Thus, following section is presented to picture out our ignorance, through the brief history of air pollution beginning from 13th century till today. The section is based mainly on the "Environmental History Timeline, which originally appeared in Mass Media and Environmental Conflict, a book written by Mark Neuzil and William Kovarik published by Sage in 1996. The first web publication of the timeline was on 6/18/96, and it was expanded in 1998 and 2001 (URL1).

The Roman Senate introduced a law about 2000 years ago, according to which: 'Polluting air is not allowed'. The Institutes issued under the Roman emperor Justinian in 535 AD were used as a text in law schools. Under the section Law of Things, our right to the air is clear: 'By the law of nature these things are common to mankind – the air, running water, the sea, and consequently the shores of the sea.' (Makra & Brimblecombe, 2004).

In 1257, Queen Eleanor of Provence was forced to leave Nottingham

Castle for Tutbury Castle because heavy coal smoke fouls the air.

In 1306, Edward I forbidden coal burning in London, but like many attempts to regulate coal burning, it has little effect.

Between 1560 and1600, rapid industrialization in England leaded to heavy deforestation and increasing substitution of coal for wood. In 1590, Queen Elizabeth was "greatly grieved and annoyed" by coal smoke in Westminster Palace.

In 1661 John Evelyn wrote "Fumifugium, or the Inconvenience of the Air and Smoke of London Dissipated" to propose solutions for London's air pollution problem.

In 1775 English scientist Percival Pott found that coal was causing an unusually high incidence of cancer among chimney sweeps.

Benjamin Franklin noted in 1784 that the switch from wood to coal had saved what remained of England's forests and he urged France and Germany to do the same.

In 1804, impacts of smoke had begun to be felt in Pittsburgh. The smoke affected the "comfort, health and peace and harmony" of the new city. As in most other cities, the solution was to build higher chimneys.

James Fenimore Cooper wrote "The Pioneers" in 1823, which contains the idea that humans should "govern the resources of nature by certain principles in order to conserve them.

Jean Baptiste Joseph Fourier wrote the first scientific reference to global warming in 1824, "Remarks on the Temperature of the Terrestrial Globe and Planetary Spaces", in which he proposed the theory that the sun's heat is partially trapped in the earth's atmosphere like a giant glass jar.

In 1848, Andrew Jackson Downing, a landscape architect, proposed creation of a 500-acre People's Park in New York, which is now known as Central Park.

Novelist Charles Dickens published his novel "Bleak House" in 1853, with an image of London as a twisted, twilight world of smoke, shadows and wraiths.

John Tyndall explained the "greenhouse effect" in 1863 in a lecture to the British Royal Society entitled "On Radiation through the Earth's Atmosphere." It was the first confirmation and extension of Joseph Fourier's idea that the earth would be much colder without its atmosphere. First of a series of "killer fogs" in London occurred in December 1873. Over 1,150 died in three days. Similar incidents happened in 1880, 1882, 1891, 1892 and later.

In 1881, Chicago became the first American city to create a local ordinance regulating smoke discharges, followed that same year by Cincinnati.

In the same year, in 1881, Norway tracked first signs of acid rain on its western coast.

Clarence Kemp, "the father of solar energy in the U.S.", patented first commercial Climax Solar Water Heater in1891.

In April, 1896, Swedish chemist Svante August Arrhenius summarized scientific opinion about the effect of carbon dioxide in the atmosphere, predicting a global temperature increase of 8 or 9 degrees F for a doubling of C02 in the atmosphere; "On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground".

In 1908, he (Svante Arrhenius) argued that the greenhouse effect from coal and petroleum use is warming the globe. Rather than being alarmed, Arrhenius was pleased that people in the future would "live under a warmer sky and a less harsh environment than we were granted."

In Glasgow, Scotland, winter inversions and smoke accumulations kill over 1,000 in 1909.

In December 1921, General Motors researchers discovered tetraethyl lead as an anti-knock gasoline additive. Despite strong private warnings about

its danger and a secret Public Health Service inquiry, the new gasoline went on sale without safety tests 14 months after it was invented.

In 1926, the first large scale survey of air pollution occurred in U.S., in Salt Lake City.

Air pollution control begun in 1928 in eastern US cities, reporting sunlight cut by 20 to 50 % in New York City.

In 1930, Meuse River Valley killer smog incident occurred in Belgium. Three-day weather inversion in this industrial valley killed 63, with 6,000 made ill.

The date 1939, October 11 was recorded as St. Louis smog episode. Smog was so thick that lamps were needed during daylight for a week.

Donora, Pennsylvania smog incident occurred in October 30-31, 1948. Twenty people died, 600 hospitalized and thousands stickered in this nationally publicized environmental disaster.

First US conference on air pollution held in 1949.

Four thousand people died in the worst of the London "killer fogs" in Dec. 4-8, 1952. Vehicles used lamps in broad daylight, but smog was so thick that busses run only with a guide walking ahead. By Dec. 8 all transportation except the subway had stopped.

In May 4, 1953, Gilbert N. Plass presented paper on global warming at American Geophysical Union.

New York smog incident killed between 170 and 260 in November, 1953. Heavy smog conditions shut down industry and schools in Los Angeles for most of October in 1954.

In 1955 International Air Pollution Congress held in New York City.

Another killer smog occurred in London in 1956; 1,000 died.

British Parliament passed Clean Air Act in 1956.

Another smog phenomenon in London caused 750 die in 1962.

A reaction took place in1962 to Silent Spring by Rachel Carson. Some agronomists asked whether Carson is intending to starve people by banning pesticides. By 1970 DDT was banned, but other more toxic chemicals were not. Silent Spring was often seen as a turning point in environmental history because it opened a much stronger national dialogue about the relationship between people and nature.

In January 1970, General Motors president promised "pollution free" cars by 1980 and urged the elimination of lead additives from gasoline in order to allow the use of catalytic converters.

In the seventies, air pollution was cut back dramatically through use of catalytic converters on new cars that use only unleaded gasoline. But the predicted "pollution free car" proved to be imaginary.

Disasters showed the weak and fragile side of industrial technology in 1980's:

Bhopal Disaster was recorded as one, 2 decades after the "Silent Spring": Bhopal is a town in India, was similar to many others before that night in December 3, 1984. Union Carbide Co. fertilizer plant leaked methyl isocyanide at 5 past midnight in Bhopal. 2000 dead, another 8,000 die of chronic effects, estimated 2000 casualties, 100,000 injuries, and significant damage to livestock and crops. The International Medical Commission on Bhopal estimated that as of 1994 upwards of 50,000 people remained partially or totally disabled.

Another disaster showing the weak and fragile side of industrial technology happened in 1986: On April 26, 1986, at 1:23 a.m. an explosion and fire occurred in Reactor Number 4 of the Chernobyl Nuclear Power Plant in the former USSR (now Ukraine), located 80 miles north of Kiev.

In the wake of the Chernobyl disaster, in 1988 Russian scientists form the

Ecology and Peace Association, electing as president S.P. Zalyghin, whose astonishing statement -- “Only the people can save nature”.

At the time when Zalyghin pointed out the people as the saver of the nature, UNEP was working on public awareness raising activities to reduce ozone layer lose. The story of success in ozone layer protection is presented by Andersen, Sarma and Taddonio (2002) and education is dedicated as one of the major contributors.

A new report released in September 2010 by the United Nations (UN), says international efforts to protect the ozone layer are a success and have stopped additional ozone losses. One phase for the ozone layer protection work realized by UNEP is related to public awareness raising activities. In most countries, improved servicing was the source of early and substantial emissions reductions. One of the components of the improved servicing, on the other hand, was training. Trade and professional associations, labour unions and private companies primarily undertook training. The objective of the ozone treaties was certainly a difficult one: to persuade the entire world to give up the use of many profitable chemicals. To be persuaded were not only the governments, but also the producers of these chemicals, all major multi- national giants of industrialized countries, and thousands of industries. Behind them were the billions of consumers who wanted and needed the products that contained ozone-depleting chemicals. (Andersen et al., 2002).

Therefore, an important role of the success in ozone layer protection is dedicated to education and training, believing that, re-establishment efforts of the equilibrium of natural systems that have already been distorted by human activities can be satisfactory on the condition that, they include the human itself. Any innovative technology produced to handle global climate change problem should consider human being who will get the advantage of it.

Education of a certain kind

In the book titled “Earth in Mind”, Orr (1994, p.6) wrote, “If one listens carefully, it may even be possible to hear the Creation groan every year

in May when another batch of smart, degree-holding but ecologically illiterate, Homo sapiens who are eager to succeed are launched into the biosphere." The things on which our future health and prosperity depend are in dire danger and according to Orr (1994) this is not the work of ignorant people, rather it is largely the results of work by people with degrees. Because what was wrong in their education is, it emphasized theories instead of values, concepts rather than human beings, abstraction rather than consciousness, answers instead of questions, ideology and efficiency rather than conscience. And he added, "It is not education but education of a certain kind that will save us." (p.8) And so, he reported several myths for this kind of education: First one is about the myth that, ignorance is a solvable problem. According to him, ignorance is not a solvable problem; it is rather an inescapable part of the human condition. The advance of knowledge always carried with it the advance of some form of ignorance. As for the case of chlorofluorocarbons (CFCs);

> *In 1929 the knowledge of what a substance like CFCs would do to the stratospheric ozone and climate stability was a piece of trivial ignorance as the compound had not yet been invented. But in 1930, after the compound discovered, what had been a piece of trivial ignorance became a critical life threatening gap in human understanding of the biosphere. Not until the early 1970's no one did ask "What does this substance to do what? In 1986 we discovered that CFCs had created a hole in the ozone over the South Pole the size of the lower 4[8] U.S. states; by the early 1990's CFCs had created a worldwide reduction of ozone. With the discovery of CFCs, knowledge increased, but like the circumference of an expanding circle, ignorance grew as well* (Orr, 1994, p.9).

Likewise, one can refer to the above mentioned history of London fog; it was 1257 when Queen Eleanor left Nottingham Castle because heavy coal smoke fouls the air. A series of "killer fogs" occurred in London in 1873, similar incidents (killer fogs) happened in 1880, 1882, 1891, 1892, in 1948, 1952, 1953 and 1962; 7 centuries later then the first sign. What's more, the disaster caused by a pesticide factory caused unavoidable impacts on the people in 1984, although Rachel Carson's Silent Spring was seen as a turning point in environmental history because it opened a much stronger

national dialogue about the relationship between people and nature in 1962. Besides, according to J. Russell (2008), in 2006, coal accounted for 25 percent of world primary energy supply. Due to its high carbon content, coal was responsible for approximately 40 percent of the carbon dioxide emissions from fossil fuels, despite supplying only 32 percent of fossil fuel energy. Management of this plentiful but heavily polluting energy resource has tremendous implications for human welfare, the health of ecosystems, and the stability of the global climate. World coal consumption reached a record 3,090 million tons of oil equivalent (MTOE) in 2006, an increase of 4.5 % over 2005. China led world coal use with 39 percent of the total. The United States followed with 18 %. The European Union and India accounted for 10 percent and 8 percent, respectively.

Furthermore, another myth Orr (1994) wrote is that, with enough knowledge and technology, we can "manage planet earth". According to Orr, however, what might be managed are us, human desires, economies, politics and communities. But, our attention is caught by those things that avoid the hard choices implied by politics, morality, ethics, and common sense. It makes far better sense to reshape ourselves to fit a finite planet than to attempt to reshape the planet to fit our infinite wants (Orr, 1994). The global trend on the use of materials, on the other hand, reveals that, we are, in the year 2011, still trying to reshape the planet: Yet, as Gardner (2010) reported, global use of materials (the food, feed, forest products, metals, and minerals that constitute the foundation of modern economies) was up 2.7 % in 2007, reminding that, materials use is a proxy indicator for environmental impact: the greater the tonnage of virgin materials extracted, processed, consumed, and disposed of, the greater an economy's environmental footprint.

All in all, the message is that, we are becoming more ignorant of the things we must conscientious to live well and sustainably on the Earth.

It was a quarter of a century ago, that education was described as the "greatest resource" for achieving a just and ecological society. Since then, a series of major international reports have emphasized the critical role education can play in the search for sustainable living. The Brundtland Report, (WCED, 1987) argued that teachers had "a crucial role to play in

helping to bring about the extensive social changes" (p. xiv) necessary for sustainable development. This message was reiterated by *Caring for the Earth* which identified education's vital role in ensuring that people learn, accept and live by the principle of living sustainably (IUCN, 2002).

From the time sustainable development was endorsed in the UN General Assembly in 1987, the parallel concept of education supporting sustainable development was being explored. From 1987 to 1992, the concept of sustainable development matured as committees discussed, negotiated, and wrote the 40 chapters of *Agenda 21*. The initial thoughts concerning ESD were captured in Chapter 36 of *Agenda 21*, "Promoting Education, Public Awareness, and Training" (UNESCO, 1992).

Climate Change Education for Sustainability

The Intergovernmental Panel on Climate Change (IPCC) concluded in 2007 that, global warming is inevitable and that human activity is likely to be the main cause. However, according to a survey of the American public in the same year (ABC News, 2007), while 33% cited climate change as the world's top environmental issue, and 84% thought it was probably happening today, only 41% of the American public believed that global warming was caused by human activity. Furthermore, while 86% believed global warming would become a serious environmental problem if not corrected, 63% thought it could be reduced, with 62% claiming they knew a moderate amount about global warming. However, reported that, only 18% of the US public agree that every time we use coal or oil or gas, we contribute to the greenhouse effect (Nisbet and Myers, 2007). What these findings imply is the importance of women, young, decision makers, teachers, … learning about the greenhouse effect in order to understand the arguments and debates about the science of global warming and climate change to promote that is knowledgeable about global warming and climate change, and one which can assume informed responsibility for the management and policymaking decisions facing our planet (Brown, 1992; Bybee, 1993 as cited in Shepardson, Soyoung, Niyogi & Charusombat, 2011).

Accordingly, climate change education for ESD has been covered in several researches all over the world and the major areas of focus are;

implementations, cultural differences in attitudes, misconceptions, factors effecting satisfactory results, problems for an effective ESD. And although there are a number of recommendations made by researchers, the targets for ESD still have not been satisfied. But, it is reality that, although research in developing ESD is the task of the education society, increasing environmental literacy is the task for all sectors, including universities, governmental authorities, NGOs, private sector, etc. The following section, therefore, highlights the recent research, focusing on the results, on developing environmental literacy, ESD implementations related to climate change and global warming.

Although air pollution has been a problem since 17th century, it has just become more complex and difficult to manage and control, requiring a growing need for improvement in public understanding of environmental science and policy. Thus, comprehensive and meaningful education is decided to be a promising avenue for equipping members of society in identifying potential solutions to environmental problems in order to protect valuable natural resources. ESD can produce an environmentally literate citizenry able to actively address environmental challenges and problems (Hungerford and Peyton, 1976; UNESCO, 1980; Roth, 1992). Therefore, comprehensive environmental education may be an important mean for societies to meet the increasing need for improved public understanding of environmental issues, trade-offs and other alternatives. The 1972 United Nations-Stockholm Conference (UNEP, 1972) helped articulate a shared outlook and set of principles for inspiring and guiding efforts focused on helping the public learn to pre-serve and enhance healthcare and environment. In 1977, an international assembly of environmental educators developed a set of definitions and principles for environmental literacy and education at the Inter-Governmental Conference on Environmental Education in Tbilisi (UNESCO, 1977). A decade later, Hines et al. (1986/87) pointed out that environmental education efforts must go beyond providing simplistic information and move towards providing: knowledge of complex environmental issues, specific knowledge about approaches for addressing such issues and decision-making skills. Hines et al. also called for efforts to change certain effective qualities (attitudes) that result in people caring about and paying more attention to environmental conditions. It seems axiomatic to observe

that the current global environmental and natural resources conditions are worse today, the world over than in the past. Therefore, it is imperative that the goals of 21st century educational systems should include environmental education and the formation of an environmentally literate citizenry able to actively participate in solving environmental problems. Disinger and Roth (1992) provide a generally accepted 'definition' of environmental literacy and have pointed out that: Environmental literacy is essentially the capacity to perceive and interpret the relative health of environmental systems and take appropriate action to maintain, restore or improve the health of those systems (p. 2).

Individuals (adults and children) may change their environmental behaviour when their values, beliefs, and pro-environmental norms change (Dietz, Fitzgerald & Shwom., 2005). Improved environmental education as well as increased environmental literacy may result in such changes. As Clair (2003) pointed out: "Environmental literacy for adults means developing and participating in the social practices likely to change the way our societies think about and act upon ecological issues. Literacy is a powerful metaphor that contributes a great deal to thinking through the question of what each of us can contribute for a more just and sustainable way of life for the planetary community" (p. 77).

Coyle (2005), in reviewing 10 years of NEETF/Roper research on environmental literacy in the United States, points out that creating more widespread environmental literacy depends on (1) bringing sound environmental education programming into the education realm, and (2) channelling public environmental literacy efforts to focus more on depth rather than accuracy. Thus, environmental literacy is distinct from simple awareness or personal conduct knowledge because of its depth of information and the actual skills (thinking and doing) imparted. Knowledge and attitudes are essential components of environmental literacy, especially if the goal of environmental education is to change behaviour. Individuals' environmental behaviours may change as a result of changes in their values, beliefs, and pro-environmental norms (Dietz et al., 2005).

A research on the environmental literacy of pre-service teachers in Turkey (TuncerTekkaya, Sungur, Cakiroglu, Ertepinar & Kaplowitz, 2009) revealed

that, the least percent (34%) of correct answer for environmental knowledge items were concerned about motor vehicles as the major contributor to carbon monoxide while more than 60% of respondents incorrectly identified factories and businesses as the major source of carbon monoxide. 77% of the teachers correctly answered the item that the ozone layer serves as a protective layer from cancer-causing sunlight. The most frequently answer received for the types of pollution "very concerned', on the other hand, was related to ''indoor air pollution'' (42%), ''ozone depletion and global warming'' (38%). However, this result was found as unexpected by the authors of this research, in light of Turkey's circumstances as a developing nation. It was reported that, perhaps, the preservice teachers do not have complete and/or first-hand knowledge about such issues. They likely do not have much exposure to the natural radioactive gas radon, a principle indoor pollutant. It is possible that pre-service teachers expressed concern about indoor air pollution thinking instead of the high use of tobacco in Turkey. Moreover, while 42% of respondents indicated that they were very concerned about ''ozone depletion and global warming,'' only 19% of them were 'very concerned' about automobile emissions. Therefore, the conclusion was that, preservice teachers in this study either do not understand the cause - effect relationship between automobiles and global warming or that their fear of more restrictions on their automobiles motivated them to answer strategically.

Besides, gender appeared to play a role in elucidating the variation in the two components of environmental literacy variables along with environmental attitude and uses. Female pre-service teachers tended to have more positive attitudes and have more responsible actions toward the environment than male pre-service teachers, which is in line with other studies (Alp, Ertepinar, Tekkaya & Yilmaz, 2006; Berberoglu and Tosunoglu, 1995; 2003; Chu et al., Huang and Yore, 2007; Tikka, Kuitunen & Tynys 2000; Worsley and Skrzypiec, 1998; Yilmaz, Boone & Anderson, 2004; Zelezny, Chua & Aldrich, 2000). For example, according to Tikka et al. (2000), whereas males are more likely to emphasize mastering nature and taking benefits from natural resources, females obtain a more emotional attitude toward nature. The reasoning behind this argument was explained through the combination of women's role as caregivers for children and their role in the household, where they do most of the house work, in addition to

working in the paid labour force. This role was explained as being in direct contrast to men's historical ''breadwinner'' role. (Weaver, 2002; p. 83).

Referring to the above mentioned definition of environmental literacy, it seems to rest on an assumption that individuals have a competent level of environmental knowledge. It is concluded in one of the recent studies realised in Turkey, to determine environmental literacy of preservice teachers (Tuncer et. al, 2009), that, a majority of Turkish pre-service teachers do not possess enough knowledge to be classified as having an acceptable level of environmental knowledge. Slightly less than half of the pre-service teachers of this study (49%) received a passing grade, based on the NEETF and Roper Starch grading scale. Yet, 66% of the students from Michigan State University (MSU) (Kaplowitz and Levine, 2005) reported to receiving a ''passing grade'' based on the same grading scale. Interestingly, in that same university, MSU College of Education students had one of the lowest mean correct scores compared with students from other MSU colleges such as agriculture and natural resources (8.84 of 11) and Natural Science (8.48 of 11). One possible explanation for the low level of passing grades for Turkish respondents' environmental knowledge, on the other hand, was explained be the absence of course works, relevant to environmental education in the current teacher education programs in Turkey. Of course, there may be demographic characteristics of students that relate to differences in academic level and environmental knowledge. Despite their low levels of environmental knowledge, Turkish respondents expressed positive attitudes toward the environment as well as high degree of concern about environmental problems. The respondents also expressed feelings of responsibility for environmental problems; expressed the view that environmental problems are one of the most important problems of their lives; and shared their feeling that they are comfortable with their background on environmental issues. Such results beg the question of what it would take to create a critical mass for increased environmental learning throughout the educational system.

In service elementary teachers' knowledge about air pollution in Turkey was the subject of another study (Tuzun, Teksöz Tuncer & Aydemir, 2008). The study pointed out specific results. One of the questions related to teachers' general knowledge about air pollution sources was that, "Which

human activities contributed to air pollution?" The answers for this question were categorized as, individual, societal, and industrial contribution. Approximately 24% of the teachers reported exhaust gases as the main cause of the air pollution. Which, was not a surprising result, considering that the study area is one of the crowded cities in Turkey with increasing number of cars and traffic problems. Use of sprays and deodorants was considered as the second main individual source of air pollution by the participants. The reason was explained in relation with not the content of textbooks but with the effect of media. Use of coal at home for heating was declared as the third most important individual source of air pollution by the teachers of the study. Besides, awareness toward environmental pollution, trash, and industrial emissions were also considered as the sources of the air pollution by the teachers.

Misconceptions of the teachers of this study about global warming and ozone layer were also detected, which pointed out the common misconception observed in the literature: Teachers have misconceptions about greenhouse effect and ozone layer depletion. In general terms, the location of ozone layer was confused with that of the greenhouse gases and stratospheric ozone with tropospheric ozone (Cutter, 2002; Michail et al., 2007; Summers et al., 2000).

Moreover, Shepardson et. al. (2011) derived five distinct mental models of the greenhouse effect from an inductive analysis of the content of the drawings and explanations of 225 students' from three different schools in the Midwest in the US. Based on the mental models identified it was apparent that students lacked a clear understanding of the greenhouse effect. At best 48% of the students realized that greenhouse gases, whatever they may be, cause the greenhouse effect and that the sun's energy is either 'trapped' by or 'bounced' back to the Earth by the greenhouse gas layer. On the other end of the spectrum, 29% of the students lacked an understanding of the greenhouse effect.

Investigation on the regional differences in 15-year-old Turkish students' awareness, perception, optimism and responsibility development toward environmental pollution issues carried out, with 4942 fifteen-year-old-students attending 160 schools across 78 provinces and 7 geographical

regions (Teksoz, Tekkaya & Erbas, 2009). Results indicated that a minority of students, across seven regions reported as they aware of the increase of greenhouse gases in the atmosphere (9.7%). Percent of students who stated that they never heard about these issues were 26.5% in average. As far as the acid rain issue has been considered, 18.2% stated that they were familiar and 9.2% stated that they never heard about the acid rain issue. Furthermore, while 63.7% of the participants believed that they were familiar with the consequences of clearing forests for other land use, 3.9% declared that they never heard about the issue. The mean scores calculated for environmental perception, environmental awareness and responsibility development components show almost the same trend in all regions. Whereas, mean values for the environmental optimism component showed a different pattern between the regions: students living in the Eastern regions seemed more optimistic than those in other regions. In the first place, the results of the study provided some evidence that the place where students live had an effect on their environmental awareness, concern, optimism and responsibility for sustainable development. For example, the most noticeable characteristic was that; although the students of the two least developed regions (Southeast Anatolia and East Anatolia) displayed lower awareness and concern toward environmental issues, they displayed the highest degree of optimism concerning the problems associated with air pollution over the next 20 years. Among the 7 geographical regions, Marmara Region, with students having comparably higher environmental concern, responsibility and lower degree of optimism, is different from the others with its being an area of industrialisation, commerce, tourism and transportation because of its close location to Europe. Thus the children living in such circumstances were more aware of air pollution problems, concerned about environmental problems and pessimistic about the future. Thus, as Matthews (1995) reviewed in his study, regional features affect children's behaviour in large-scale environments and it follows that as the life worlds of children from different socio cultural backgrounds differ, the way in which children encounter place and make sense of their everyday worlds are also likely to be at variance. Therefore, it may be concluded that, "area of residence may be a silent predictor of responsible environmental behaviour". Therefore, efforts for creating environmentally literate generations need to consider regional socio-economical features as well as the people's perceptions towards environmental issues. Such

an evaluation will be very valuable leading the education specialists to establish a national strategy for and will help to make the strategy regional, as suggested in Chapter 36 of Agenda 21 (UNCED, 1992).

Discussion and Conclusions

In his article published in 2009, Orr wrote about Napolean's invation of Russis on 24 June 1812 with no clear idea of what he intended to do. As Orr wrote (p. 790); "Napoleon made a series of bad decisions, beginning with the one to invade Russia. But having done so and having gotten as far as Moscow in the fall of 1812, he made two decisions thereafter that proved fatal to his army and to the French empire. One was to tarry in Moscow for 5 weeks with the Russian winter approaching. The second was to permit his soldiers to load up with plunder that encumbered their escape, weighed down their knapsacks and wagons, undermined discipline, and diverted their attention from the serious business of escaping disaster." According to Orr, "Rather like Napoleon's Grand Army, we, too, are in a race; we were first warned of climate change over a century ago and have lingered in increasingly dangerous territory in the belief that we can return to safer ground on our terms with all of the booty seized at the apogee of fossil-fueled industrial era. …There will be unavoidable and tragic losses in the decades ahead, but far fewer if we act to contain the scope and scale of climate change now. That is to say that there is some baggage accumulated in the fossil fuel era of our recent history that we cannot take with us. No matter what we do to adapt, we cannot save some coastal cities, we will lose many species, and ecosystems will be dramatically altered by changes in temperature and rainfall. Our best couvrse is to reduce the scale and scope of the problem with a sense of wartime urgency. And we better move quickly and smartly while the moving's good (p. 792-793)."

In spite of the efforts for developing ESD all over the world, how could we be so ignorant on our responsibilities about the visible impacts of climate change?

Efforts for developing ESD as a tool for adapting and mitigating for climate change therefore continues under the light of the research, several examples of which are summarised above. Although there are international conventions leading such efforts, regional, national and local strategies are

needed to get more effective outputs. Efforts, although concentrated in teachers' education, shall diffuse to all areas, engineering being one of the vital one. Ashford (2004) pointed out the concern as follows: "Scholars and professionals committed to fostering sustainable development have urged a re-examination of the curriculum and the restructuring of research in engineering-focused institutions of higher learning. The focus is on engineering, more than on the natural and physical sciences or on social science, because the activities that drive the industrial state – the activities that implement scientific advance – are generally rooted in engineering. Moreover, engineers are known as 'problem solvers' and if economies are becoming unsustainable because of engineering, it is natural to ask whether engineering as an activity and as a profession can be re-directed toward achieving sustainable transformations. Of course, engineering cannot do it alone; scientific as well as social and legal changes must occur as well" (p.239).

Nevertheless, results of research investigating people awareness, attitudes and behaviour on environmental pollution issues have a single common result that, most of the people from different countries with different socio-demographic features and life styles, are aware of the natural resources, are vulnerable and deserve conservation for the sake of supporting human life or just for the health of itself. Most of the people have an eco-centric approach to the natural sources. But beyond this point, when it comes to individual responsibilities, i.e. making changes in living styles for natural protection, such as preferring public transport instead of private cars or using less energy at home, the approach slides through anthropocentrism. Or, citizens both in the developing and developed world cannot make a relation between, for example the way we eat or the way we shop and the global warming, which as a result makes it difficult to make a change. ESD is a powerful tool in our hand to make people aware of such relations and get rid of the ignorance we have been carrying since 17th century.

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