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Loss of biodiversity and climate change as presented in biology curricula for Ethiopian schools: Implications for action-oriented environmental education

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Schools, as institutions for general education, are believed to have a responsibility to equip their students with the knowledge and commitment to take personally meaningful decisions and action to address the challenges posed by both lifestyle and societal conditions. Achieving this goal requires, among other things, adequate integration of the 'challenges' into the school curricula. This paper reports results of a study that assessed whether (and the extent to which) loss of biological diversity and climate change have been incorporated into Biology curriculum guides for Ethiopian secondary and preparatory schools. To this end, content analysis has been used as a principal technique. The findings revealed that the revised curriculum guides have integrated a number of issues that could enhance understanding about the significance of biodiversity and consequences of its loss. Issues related to biodiversity have been addressed, in one form or the other, in all grades except grade eleven. When it comes to climate change, the revised curriculum guides offer little opportunity to integrate the issue. The paper thus argues that, where such issues are not 'manifestly' integrated into the curriculum guides, one cannot expect concrete action planned and executed against loss of biodiversity and climate change. The paper calls for redressing some of the observed limitations through interdisciplinary collaboration and/or revision of existing content.

Key words: Action, biodiversity, climate change, content analysis, curriculum guide, environmental education

Introduction

Interplay between Loss of Biodiversity and Global Climate Change

At the global level, human activities have caused a loss in biodiversity through, inter alia, land-use and land-cover change; soil and water pollution and degradation, and air pollution; habitat fragmentation; selective exploitation of species; and the introduction of non-native species (Gitay et al., 2002). It is further argued that the "current rate of biodiversity loss is greater than the natural background rate of extinction" (Gitay et al., 2002, p.1). Changes in climate are known to exert additional pressure on biodiversity. Climate change has affected, for instance, the timing of reproduction in animals and plants, the length of the growing season, species distributions and

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population sizes, and the frequency of pest and disease outbreaks (this paper considers loss of biodiversity and climate change as two separate though interrelated environmental challenges).

Global climate change is also projected to affect all aspects of biodiversity including individual organisms, populations, species distributions, and ecosystem composition and function both directly (e.g., through increases in temperature and changes in precipitation and in the case of marine and coastal ecosystems also changes in sea level and storm surges) and indirectly (e.g., through climate changing the intensity and frequency of disturbances such as wildfires) (Gitay et al., 2002). On the other hand, changes in biodiversity at ecosystem and landscape scale would further affect global and regional climate through, for instance, changes in the uptake and release of greenhouse gases. Similarly, structural changes in biological communities in the upper ocean could alter the uptake of CO_2 by the ocean.

Ethiopia: Loss of Biodiversity

It is estimated that 80,000-200,000 hectares of forestland is cleared per annum in Ethiopia for various reasons (EPA, 2002). The forest cover, which is often claimed to amount to 35 to 40 per cent of the area of the country a century ago, had dwindled to 2.7% at the end of the 20th century. More recently, there are indications that marked improvements have been registered in forest cover over the past ten years or so. A recent report by the Ethiopian Ministry of Agriculture and Rural Development announced, for instance, that the country managed to increase its forest cover three fold: to 9% (ENA, 2010). Such a dramatic increase was attributed to the afforestation campaigns; and river basin-based natural resources conservation activity undertaken over the last 10 years. From this perspective, one can hope that the downhill spiral of environmental degradation is being controlled, if not fully stopped. Nevertheless, some environmentalists (environmental activists in a local civil society organisation) were quick to cast doubts on the report suggesting that the rate of survival of the planted seedlings was too low (for these people, 20% maturity of seedlings is a great success!) (PANA, 2010). The environmentalists also argue that forest cover increases only if destruction of existing forests decreases significantly (at least proportionally). The trend in Ethiopia is still of deforestation, according to an environmentalist quoted in PANA. It thus appears that the debate around the 'downhill spiral of environmental degradation' would continue until a clear reversal of the trend is visible on the ground. At this juncture, it is also important to note that deforestation is related in Ethiopia not only to loss of biodiversity but also to the growing problem of climate change.

Climate Change in Ethiopia: Magnitude and Impacts

The recently published 'Ethiopia Environment Outlook' report indicates that climate variability and change are among the pressing issues already affecting the livelihood of most Ethiopians (EPA & UNEP, 2008). The country experienced a clear warming trend in the annual minimum temperature over the past 55 years which has been increasing by about 0.37^0C every ten years (Tadege, 2008). In the case of rainfall, variability is more of a concern than its amount. The space-time variability, and in some cases severe shortage, of precipitation over the past decades led to recurrent and substantial shortfalls in agricultural production, which, in turn, led to famines that claimed tens of thousands of human and animal lives (Admassie et al., 2008; EPA and UNEP, 2008; Haakansson, 2009; Hellmuth et al., 2007; Mesfin, 2003; Tadege, 2008). Factors that make Ethiopia exceptionally vulnerable to climate variability include increasing population which led to expansion of agriculture onto marginal lands; environmentally damaging agricultural and grazing practices; and the direct dependency on rain-fed agriculture (EPA & UNEP, 2008).

Efforts to Address Environmental Problems

The past decade witnessed a number of policies and strategies designed by the Ethiopian government in an effort to address key environmental problems including loss of biodiversity and climate change (EPA & UNEP, 2008; PANE, 2007). Nevertheless, the implementation of the various environment-related policies has been constrained, in general, by the gaps between policy and practice and limited stakeholder participation (McKee, 2007). A relatively recent study that specifically reviewed the level of integration of climate change into major policy documents in Ethiopia concludes that "issues pertaining to climate change and the vulnerability of Ethiopia is not yet sufficiently addressed" (PANE, 2007, p.7). The same study strongly suggests that climate change issues be mainstreamed into the national development plans and processes so as to reduce the impacts of climate change on the development of the country.

The suggestion to mainstream environmental issues or problems into national development plans seems to have been well taken by those who designed the recently launched Ethiopian 'Growth and Transformation Plan (GTP)'. The GTP is a medium term strategic framework for the five-year period (2010/11-2014/15) with major objectives including "expanding and ensuring the qualities of education and health services thereby achieving the MDGs in the social sectors" (MoFED, 2010, p. 7). The GTP has identified a number of issues that are essential for the attainment of its objectives. One of the cross-cutting issues identified is 'environment and climate change'. It is thus interesting to see that environmental concerns, including climate change, have now been recognised as crosscutting issues in one of the most important policy documents. The document (GTP) duly emphasises that environmental conservation has vital contribution for sustainability of development and calls for "building a carbon neutral and climate resilient economy and enforcement of existing environmental laws" as priority actions (MoFED, 2010, p.77). The document also underlines that "the formulation and implementation of a climate change adaptation program is a dictate of Ethiopia's survival".

The Problem

The foregoing section shows that an important step has been taken by the Ethiopian government to integrate environment and climate change into one of the key policy documents. One can, nevertheless, ask whether there is the capacity needed to implement such an important plan. Recent studies reveal that the effectiveness of adaptation measures planned by the government has been undermined by several factors including lack of resources and capacity (Haakansson, 2009). The Ethiopian State Minister of Agriculture and Rural Development also admits that the greatest challenge undermining efforts to address the problem of climate change is shortage of qualified people who can turn the many government programs into reality (Haakansson, 2009). One of the strategies to boost the capacity required for combating the adverse effects of environmental degradation is undertaking a problem or action oriented environmental education (Jensen & Schnack, 2006).

Action-oriented Environmental Education

Jensen (2002) argues that the overall aim of environmental education at school is to develop the abilities of students to act at the personal and societal levels, that is, to increase their action competence. He presents four aspects/dimensions of action-oriented environmental education (Fig. 1). Action, in the context of action competence, has been defined in view of two elements (Jensen & Schnack, 2006). First, action refers to a decision to do something, alone or together with others, "whether it is a question of a change in behavior or an attempt to influence the conditions

of life" (Jensen and Schnack, 2006 p.476). Second, "an action must be targeted towards solutions of the problem that is being focused on" (Jensen and Schnack, 2006, p.477; Mogensen and Schnack, 2010). A distinction is also made between activity and action. Activities like excursions to natural areas, scientific investigation of polluted water course, etc. are considered as valuable and productive to the extent that they help motivation and the acquisition of knowledge but, in order to be categorized as actions, they must be addressed to solution of the problem which is being investigated (Jensen & Schnack, 2006).

Dimension I:	Knowledge about the existence and spread of environmental problems and their consequences
Dimension II:	Knowledge about root causes of environmental problems
Dimension III:	Knowledge about strategies for change (about how to control one's own life and how to contribute to changing living conditions in society at large)
Dimension IV:	Knowledge about alternatives and visions (possibilities for forming and developing one's dreams and ideas for the future; and about how people go about things in other cultures and other places, both near and far).

Source: Jensen, 2002

Figure 1. Aspects/dimensions of action-oriented knowledge

Action is thus understood as a specific activity aimed at "solving the problem or changing the conditions or circumstances that created the problem in the first place" (Mogensen & Schnack, 2010, p.61). The traditional, science-focused approach to environmental education has been criticized for leading to knowledge about the existence of environmental problems, about their scope and size, but still not leading to action competence (Jensen & Schnack, 2006). Similarly, the overall system of education in Ethiopia has been criticized for inability to build a problem solving capacity: "The absence of interrelated contents and mode of presentation that can develop student's knowledge, cognitive abilities and behavioral change…, to adequately enrich problem-solving ability and attitude, are some of the major problems of our education system" (FDRE, 1994, p.2). The current education and training policy hence makes a desperate call for education at all levels to strive to develop a problem solving capacity.

A Call for Developing Problem Solving Capacity

The 1994 education and training policy puts a marked emphasis on problem solving in general and the need for seeking practical solution to environmental problems in particular (FDRE, 1994). The policy underlines, for instance, that one of the aims of education is "to strengthen the individual's and society's problem-solving capacity, ability and culture starting from basic education and at all levels" (FDRE, 1994, p.1). Similarly, education is believed to help its participants to "improve, change, as well as develop and conserve his environment for the purpose of an all-rounded development". In a bid to redress the observed gaps, the 'new' policy calls for emphasizing "development of problem solving capacity and culture in the content of education, curriculum structure and approach" (FDRE, 1994, p.4).

One and a half decades after the launching of the aforementioned policy, the Ethiopian education system has increasingly been criticized for failure to enable students to contribute towards environmental protection (Tedla, 2010). Tedla strongly argues that "the educational system in Ethiopia does not pay enough attention to the greatest challenge Ethiopia is facing at present (i.e. environmental degradation)" (Tedla, 2010, p.8). The study reported here tried to assess the extent to and ways in which two of the environmental problems, i.e. loss of

biodiversity and climate change, have been addressed in Biology curriculum guides for Ethiopian schools.

Rationale and Objectives

Globally, Biology- and Geography Education are widely believed to have a significant contribution to creating understanding about such environmental issues as loss of biodiversity and climate change. By exploring the place of these issues in the curricula for Ethiopian schools, this study tries to shed light on whether Biological Education in Ethiopia is in a position to empower students to understand the two environmental issues mentioned above. This way, the paper hopes to add its share to the wealth of information on the contribution of schooling to understanding of global environmental issues. The fourth Ethiopian educational sector development plan (ESDP IV) came up, for the first time, with a grand plan to improve the content and modalities of environmental education in the country (MOE, 2010). 'Environmental education and protection' now forms one of the seven crosscutting issues identified as issues of particular importance. The document declares that 'environmental education and protection' will be included in the curriculum at all levels; and all administrators, teachers and students will be aware of the importance of environmental education and protection. The document underscores that focus would be put on science subjects while integrating environmental education and protection so as to make it possible for a significant share of students to be introduced to the importance of this issue to sustainable development. The following are some of the specific activities and their respective success indicators for the plan period (Table 1).

Table 1. Specific activities and success indicators related to environmental education and protection indicated in ESDP IV*

Activities	Success indicator for plan period
o Environmental education and protection will be included in the curriculum at all levels	o At least 50 % of students followed a course or program on environmental education and protection
o Developing relevant curriculum materials	o Number of curriculum materials developed
o Inclusion of environmental education and protection in teacher training	o % of teacher trainees who have followed a course on environmental education and protection
o All administrators, teachers and students will be made aware of the importance of environmental education and protection	o At least 50% of teachers made aware of the importance of environmental education and protection
o Broadcasting awareness-raising programs on educational television	o Number of programs broadcast
o Awareness-raising for educational experts will be organized	o Number of experts participated in awareness-raising events
o Awareness-raising and in-service training programs organized for teachers and ABEC** facilitators	o Number of facilitators and teachers participated in awareness-raising and in-service training events
o Environmental education and protection clubs will be created in all schools	o % of schools with such clubs

Source (MOE, 2010, p. 80)

*ESDP is a five year Education Sector Development Program used as an indicative plan for the entire educational sector; and translated into similar plan at regional level.

** ABEC refers to Alternative Basic Education Centers

It is really encouraging to see such a grand step taken by the Ethiopian Ministry of Education to integrate environmental concerns into the educational system at all levels. The effort to

set indicators that help to measure success at the end of the plan period is another step in the right direction. One should equally emphasize here that measuring success at the end of the plan period requires, among other things, having clear information about the baseline from where success is to be measured. 'Developing relevant curriculum materials' requires, for instance, systematically reviewing all the existing materials so as to examine their strengths and limitations. This paper reports results of part of a study conducted to assess the degree to and ways in which some of the key environmental issues have been integrated into the curricula for Ethiopian schools and institutions of higher education. The part reported here deals with Biology curriculum guides (in Ethiopian situation, curriculum guides act as one of the most essential educational documents that dictate the content and style of students' textbooks, teachers' guides, teaching materials, etc.).

One of the revised curriculum guides for Biology declares that "many of the contemporary issues and problems in the society are essentially biological in nature. Nutrition, health, drug abuse, agriculture, pollution, rapid population growth, environmental depletion and conservation are some examples. If these problems are to be dealt with realistically, an understanding of biological knowledge is required" (MOE, 2009b, np). The study reported here was therefore aimed at assessing the extent to and ways in which two of the 'contemporary issues and problems' have been actually integrated into the curriculum guides for Ethiopian schools' Biology at secondary and preparatory levels. The specific objectives of the study were to:

- assess the extent to and ways in which issues related to loss of biodiversity and climate change have been integrated into Biology curriculum guides for grades nine to twelve;
- examine how the Minimum Learning Competencies (MLCs) specified in the new curriculum guides are related to action-oriented knowledge as postulated by Jensen (2002); and
- compare the old and new curriculum guides with respect to the degree of integration of loss of biodiversity and climate change.

The paper thus tries to answer the following questions:

- In what ways and to what extent have issues related to loss of biodiversity and climate change been integrated into Biology curriculum guides for grades nine to twelve?
- How are the Minimum Learning Competencies (MLCs) specified in the new curriculum guides related to action-oriented knowledge as postulated by Jensen (2002)? and
- Is there any difference between the old and the new curriculum guides with respect to the degree of integration of loss of biodiversity and climate change?

Methodology

As indicated earlier, this paper reports part of a larger study motivated by a desire to know whether (and the extent to which) loss of biodiversity and climate change have been integrated into the curricula for Ethiopian schools and higher education institutions. The part of the study reported here was specifically aimed at assessing the curricula of Biology for secondary and preparatory schools. To this end, content analysis has been used as a principal technique. Content analysis is defined as "a research technique for objective, systematic and quantitative description of the manifest content of communication" (Berelson, 1952 quoted in Asgedom, 1998, p.3). In such an exercise, the content of a text or discourse (in, for example, textbooks or curricular materials) is "subjected to a critical analysis in order to glean its explicit and often implicit meaning" (Lenglet, 2009, p.93). Content analysis has also been presented as "a careful, detailed, systematic

examination and interpretation of a particular body of material in an effort to identify patterns, themes, biases, and meanings" (Berg, 2007, p.303-304).

The paper analyses two versions of curriculum guides for Biology: the new version being used following the 2009 revision (MOE, 2009a; MOE, 2009b) and the old version (MOE, 2004) used before its replacement with the 2009 version. Attempt has been made to examine the changes introduced in the new guides, with regard to the two environmental issues investigated here. The number of periods allotted to issues related to biodiversity and climate change has been used as a unit to compare the two versions of the curriculum guides. On the other hand, a more rigorous analysis has been conducted on the recently revised curriculum guides (MOE, 2009) based on the following steps:

Step One: Determining Analytical Categories

Five issues related to biodiversity and climate change have been used as analytical categories: a) observed and projected changes in climate; b) observed changes in biodiversity associated with climate change; c) projected impacts of climate change on biodiversity and vice versa; d) potential effects of activities undertaken to mitigate climate change; and e) climate change adaptation activities and biodiversity. The five analytical categories are further divided into 13 sub-categories (see Fig. 2).

A. Observed and projected changes in climate; including changes in:
   - *A1. Atmospheric concentration of GHGs*
   - *A2. Earths' surface temperature and precipitation*
   - *A3. Snow cover, glaciers and sea level*
   - *A4. Climate variability and extreme climate events*

B. Observed changes in biodiversity associated with climate change; including changes both in *terrestrial species distribution, size and composition; and coastal and marine systems*

C. Projected impacts of climate change on biodiversity and vice versa; including impacts of:
   - *C1. Climate Change on biodiversity of terrestrial and coastal and marine ecosystems*
   - *C2. Changes in biodiversity on regional and global climate*

D. Potential effects of activities undertaken to mitigate climate change; including effects of:
   - *D1. Afforestation and reforestation*
   - *D2. Improved land management*
   - *D3. Agroforestry*
   - *D4. Improved forest management*
   - *D5. Enhanced use of renewable energy sources*

E. Climate change adaptation activities and biodiversity:
   - *E1. Potential effects of adaptation measures on biodiversity*
   - *E2. Synergies between conservation and sustainable use of biodiversity and climate change*

Source: Adapted from Gitay *et al.* (2002)

Figure 2. A checklist (coding frame) used for assessing the infusion of issues related to climate change and biodiversity

Step Two: Establishing Units of Analysis

Period allotment for issues related to loss of biodiversity and climate change has been used as a unit to compare the two versions of the curriculum guides. Besides, the minimum learning competencies (MLCs) identified in the revised curriculum guides have been used to measure the extent to which aspects biodiversity and climate change have been integrated into curriculum guides. The revised curriculum document defines the MLC as 'the minimum that a student must learn in each grade level in terms of content and skills' (MOE, 2009). There are a total of 432 MLCs stated for the four grades; and 37 (8.6%) of the MLCs are related to biodiversity and climate change (see also Fig. 3).

Step Three: Determining Criteria for Sorting Data into Analytic Categories

The criteria used here is clear (manifest) reference, in the MLCs, to issues related to biodiversity and climate change. As indicated in step one, a number of sub-categories have been identified for each of the five analytical categories, except the second category (Fig. 2).

Step Four: Counting the Number of Entries in Each of the Five Categories

This has been undertaken by carefully counting cases (MLCs related to the five analytical categories and their sub-categories) as presented in the revised curriculum guides for grades nine to twelve. As the writer was not in a position to hire additional coders, the counting and coding have been conducted by himself.

The paper employed quantitative techniques to analyze information and present results. The extent to which issues related to loss of biological diversity and climate change have been integrated into the curriculum guides for secondary school Biology has been assessed quantitatively by computing the proportion of MLCs devoted to biodiversity and climate change in each grade. The paper also tried to assess how the Minimum Learning Competencies (MLCs) specified in the new curriculum guides are related to action-oriented knowledge as postulated by Jensen (2002), by computing the percentage of MLCs that fall under each of the four aspects of action-oriented knowledge.

Results

The Place of Biology in Ethiopian Schools' Curriculum

The New Education and Training Policy (NETP) identifies five core subjects both for primary and secondary levels (Ethiopian National Agency for UNESCO, 2001). These are Language, Mathematics, *Natural Science*, Social Science and Aesthetic Education (in secondary level, Aesthetic Education is replaced by Physical Education). The *Natural Science* core subject at secondary and preparatory levels (grades 9-12) becomes distinctly differentiated as Biology, Chemistry and Physics. The period allotment to each of the core areas is shown in Table 2.

Official documents thus indicate that Biology as a school subject appears for the first time in grade seven and goes up to grade twelve. In grades seven and eight, all students attend three periods of Biology per week. The period allotment is raised to four in grades nine and ten (Table 2). The second cycle of secondary education (preparatory level), has two areas (streams) of specialization: *Natural Science* and Social Science. Biology forms part of the *Natural Science* stream along with physics, chemistry and mathematics (Table 3). In grades eleven and twelve, Biology is attended only by students in the *Natural Science* stream. Assessment of the revised curriculum guide (2009 version) for Ethiopian secondary and preparatory schools shows that

Biology has been allotted 119 periods per academic year on average (102 periods in grades nine and ten; and 136 periods in grades eleven and twelve) (Table 4-7).

Table 2. Period allotment in the secondary level (grade 9-10)

S/n	Core Area	Subject	Grade	
			9	10
1	Language	English	6	6
		Optional language Amharic	3	3
2	Mathematics	Mathematics	6	6
3	Natural Science	Physics	4	4
		Chemistry	4	4
		Biology	4	4
4	Social Science	Civics	2	2
		Geography	2	2
		History	2	2
5	Physical Education	Physical Education	2	2
Total periods per week			**35**	**35**

Source: Ethiopian National Agency for UNESCO, 2001, p.30

Table 3. Areas of specialization in the preparatory level (grade 11-12)

Streams	Specialized subject	Common subject	Elective
Natural Sciences	1. Physics	1. English	1. Nationality Language
	2. Chemistry	2. Civics	2. Foreign Language
	3. Biology	3. Physical Education	
	4. Math		
Social Sciences	1. History	1. English	1. Nationality Language
	2. Geography	2. Math	2. Science course
	3. Civics	3. Physical Education	3. Foreign Language

Source: Ethiopian National Agency for UNESCO, 2001, p.31

Loss of Biodiversity and Climate Change in Biology Curriculum Guides

Ogbuigwe (2009, p.21) argues that, in Africa, there is a need for "domesticating environmental education in order that it addresses the present and foreseen environmental challenges that the continent is facing, laying a particular emphasis on adaptation and mitigation of climate change effects". Biology, as one of the school subjects known for advancing the goals of environmental education, can thus be expected to address loss of biodiversity and climate change as two of the key environmental challenges facing Ethiopia and the world at large. What is more, the writers of the Biology curriculum guides believe that "many of the contemporary issues and problems in the society are essentially biological in nature" (MOE, 2009b, np). It was with this background that this study sought to assess how loss of biological diversity and climate change, as two of the 'contemporary' issues, have been treated in Biology curriculum guides. The following section presents results of analysis of the curriculum guides at grade level.

Grade Nine

Biology in grade nine has been divided into six units in the newly revised curriculum guides (there were seven units in the old). The new guide gives lesser number of periods (102 against 140 in the old curriculum). It has been noted in the revised document that though the academic calendar is made up of 40 weeks, the syllabus is prepared for 34 weeks (102 periods) so as to create a wider chance for teachers to use the remaining time (about six weeks) for such tasks as revision and conducting student projects (MOE, 2009a). The reduction of content in the revised curriculum guides was also hoped to ensure that the curriculum would be fully covered within the academic year. When it comes to specific units, a new unit entitled 'Biology and technology' has been introduced and three units are modified and/or abridged (Table 4).

Table 4. Grade nine Biology units in the old and new curriculum guides

Unit Title	**Periods allotted in the old curriculum (%)**	**Periods allotted in the new curriculum (%)**	**Changes introduced in the new curriculum**
Biology and technology	---	3 (2.9)	Newly introduced
Cells	12 (8.6)	17 (16.7)	Renamed as 'Cell Biology'
Human biology and health	---	37 (36.3)	Redesigned
Nutrition and digestion	22 (15.7)	---	
Breathing and respiration	20 (14.3)	---	
Transport in living things	20 (14.3)	---	
Organisms and their environment	21 (15.0)	15 (14.7)	Renamed as 'environment'
Microorganisms and diseases	20 (14.3)	17 (16.7)	
The diversity of life and classification	25 (17.9)	13 (12.7)	Renamed as 'classification'
Total	**140 (100.0)**	**102 (100.0)**	

The new grade nine Biology curriculum guide has two units (together accounting for 27.4% of the periods) clearly related to loss of biodiversity and climate change. These units, entitled, '*Classification*' and '*Environment*' account for 12.7 % and 14.7% of the total periods allotted for the grade, respectively. The following are the sub-topics suggested to be covered under the two units: principles of classification; the five kingdoms; ecosystem; food relationships; recycling in nature, adaptations; and tree growing project. One should underline here that though the curriculum guide gives opportunities for integration of issues related to loss of biological diversity and climate change, the problems have not been clearly recognized as issues deserving a curricular space at least at a 'sub-unit' level.

Table 4 also shows that the unit related to biodiversity suffered a marked reduction in period allotment (from 17.9% in the old curriculum to 12.7% in the new). This would obviously have a negative effect on efforts to integrate issues related to loss of biodiversity in successive phases of curriculum designing, including preparation of students' textbooks and teachers' guides. Period allotment to the unit on environment remained almost the same (15% in the old curriculum and 14.7% in the new).

Grade Ten

Grade ten Biology has been organized under five units in the revised curriculum guide (the old guide had eight units). The number of periods has also been reduced from 122 to 102 for the same reasons indicated earlier (under grade nine above). Only one of the five units in the new guide raises issues related to loss of biological diversity. This unit, entitled *'Natural resources and their conservation'*, has the following sub-topics suggested to be covered: definition of terms; conservation of biodiversity; vegetation; wildlife; and air. The period allotment for this unit has increased from 9.8% in the old curriculum to 13.7% in the new (Table 5). On the other hand, climate change has not been mentioned anywhere in the list of sub-topics that make up the new curriculum guide.

Table 5. Grade ten Biology units in the old and new curriculum guides

Unit Title	**Periods allotted in the old curriculum (%)**	**Periods allotted in the new curriculum (%)**	**Changes introduced in the new curriculum**
Biotechnology	8 (6.6)	6 (5.9)	
Heredity	---	16 (15.7)	Redesigned
Genetics and evolution	22 (18.0)	---	
Human biology and health	---	44 (43.1)	Redesigned
Coordination	25 (20.5)	---	
Regulation	12 (9.8)	---	
Reproduction	18 (14.8)	---	
Food manufacturing in green plants	15 (12.3)	22 (21.6)	Restated as 'Food making and growth in plants'
Response in plants	10 (8.2)	---	
Natural resources and their conservation	12 (9.8)	14 (13.7)	
Total	**122 (100.0)**	**102 (100.0)**	

Once again, it is important to note that the absence of topics or sub-topics related to the problem of climate change in the curriculum guides affects their inclusion in other materials like students' textbook and teachers' guides that are to be prepared on the basis of these guides. Though one cannot entirely dismiss the possibility of integration of such topics by well informed textbook and teachers' guides writers, the chance for inclusion would be much lesser as curriculum guides are often followed verbatim in such processes.

Grade Eleven

The revised curriculum guide introduced a major change in the content of grade eleven Biology, with only three of the six units retained from the old guide (Table 6). The new guide does not have any unit or sub-unit directly related to the environmental problems discussed in this paper, namely, loss of biodiversity and climate change. It is also worth emphasizing that these issues were adequately addressed in the old curriculum. The old curriculum had a unit entitled *"Ecology*", which claimed one forth of the periods allotted to the grade (Table 6). Among the issues covered in this unit (old guide) were environmental limits to population growth, and 'the dilemma of biodiversity conservation and development (exploitation vis-à-vis sustainability)'.

Table 6. Grade eleven Biology units in the old and new curriculum guides

Unit Title	**Periods allotted in the old curriculum (%)**	**Periods allotted in the new curriculum (%)**	**Changes introduced in the new curriculum**
The science of Biology	19 (14.0)	29 (21.3)	
Biochemical molecules	---	24 (17.6)	Newly introduced
Enzymes	17 (12.5)	27 (19.9)	
Cell Biology	25 (18.4)	29 (21.3)	
Energy transformation	---	27 (19.9)	
Common properties of living things	22 (16.2)	---	Not included
Behavior	19 (14.0)	---	Not included
Ecology	34 (25.0)	---	Not included
Total	**136 (100.0)**	**136 (100.0)**	

Factors threatening biodiversity in the world in general and Africa in particular were well articulated in the old curriculum. Besides, an interesting discussion was made under a topic-- the 'dilemma of conservation and development' in Ethiopia. Here efforts were made to introduce the debate underpinning the balance between preservation and use of environmental resources. The following statement in students' textbook highlights the massage the writers wanted to get across: "Only when we value high biological diversity and ecosystem functioning as the heritage of all human kinds, a heritage to be passed along to our descendants as rich and full as possible, will the current alarming rate of ecosystem destruction and extinction of species be reduced" (MOE, 2006a, p.220). The revised curriculum guide (2009 version) does not seem to encourage such a critical reflection on biodiversity as the unit on 'Ecology' is cancelled or moved to grade twelve (Tables 6 and 7). This makes grade eleven a level with the least prospect for integration of loss of biodiversity and climate change.

Grade Twelve

Biology in this grade has five units, one of the units, entitled *'Ecology'*, having topics directly related to loss of biodiversity (Table 7). This unit accounts for 22.1% of the periods and has the following sub-topics: cycling of matter through ecosystems; ecological succession; biomes; biodiversity; and population structure and dynamics. One can thus see a good opportunity to address one of the two environmental problems being discussed here, i.e. loss of biodiversity. On the other hand, the new guide has no units or sub-units related to climate change.

The old curriculum had a unit entitled *'Biology and human welfare'* which contained issues related to climate change (Table 7). Besides, the old curriculum puts a marked focus on the extent of deforestation taking place in Ethiopia and its consequences. The effects of drought in the northern parts of Ethiopia had been presented as a project activity where students were asked to explain the causes of drought, their opinion as to what would happen if the number of population kept on increasing in southern parts of the country, and possible strategies to prevent the occurrence of similar drought in the southern and southwestern parts of the country (MOE, 2006b, p.218). The new curriculum (2009 version) seems to have little chance to initiate such a thought provoking assessment on the part of the textbook writers as the respective unit is now removed from the curriculum guide.

Table 7. Grade twelve Biology units in the old and new curriculum guides

Unit Title	**Periods allotted in the old curriculum (%)**	**Periods allotted in the new curriculum (%)**	**Changes introduced in the new curriculum**
Micro-organisms	---	30 (22.1)	
Ecology	---	30 (22.1)	
Genetics	32 (27.1)	26 (19.1)	
Evolution	14 (11.9)	25 (18.4)	
Behavior	---	25 (18.4)	
Cell Biology	25 (21.2)	---	Not included
Viruses	7 (5.9)	---	Not included
Development	15 (12.7)	---	Not included
Biology and human welfare	25 (21.2)	---	Not included
Total	**118 (100.0)**	**136 (100.0)**	

Integration of Specific Aspects of Biodiversity and Climate Change

As indicated in the methodology section, 37 of the 432 MLCs identified for the four grades deal with issues related to aspects biodiversity and climate change (Table 8). Two of the sub-categories under the first category, namely, changes in concentration of GHGs and increase in temperature and precipitation have been addressed in 11 of the 37 MLCs (29.7%). The other sub-categories in the first category (Category A: changes in glaciers and sea level; and extreme climate events) have not been dealt with. Grade nine has more issues of this category covered followed by grade ten. Category B, which deals with the link between climate change and loss of biodiversity, has been touched only slightly in grade twelve. Only two of the 37 MLCs address this aspect of biodiversity and climate change. One can thus clearly see that the issues related to climate induced changes in biodiversity have been poorly addressed in the curriculum guides.

Category C, projected impacts of climate change on biodiversity and vice versa, has been addressed in six of the MLCs whereas Category D in nine MLCs. It is also important to note here that only two of the five sub-categories that make up Category IV have been given due consideration (Table 8). This shows that the curriculum guides give inadequate space for discussions on potential effects of activities undertaken to mitigate climate change. One the other hand, activities related to adaptation to climate change in general and 'synergies between conservation and sustainable use of biodiversity and climate change' in particular got a relatively better coverage with nine of the MLCs dealing with issues related to adaptation measures. Finally, it is important to underline that Biology at grade eleven has no MLCs directly related to loss of biodiversity and climate change.

Contribution to Action-oriented Knowledge

This study also attempted to relate the MLCs to the four aspects of action-oriented knowledge as postulated by Jensen (2002). It is found that half of the MLCs fall under *Dimension I* of Jensen's classification, i.e. 'knowledge about the existence and spread of the problems and their consequences' (Fig. 1). The fourth *Dimension*, knowledge about alternatives and visions, is least represented with only 8.8% of the MLCs falling under it. Nearly one fourth of the MLCs (23.5%) relate to Dimension III of Jensen's classification while the remaining 17.6% fall under Dimension II (Fig. 3). It is thus interesting to see that all the Dimensions have been represented in the curriculum guides though with a marked emphasis on Dimension I which is a typical feature of a

traditional science curriculum. In traditional environmental education, "the focus is on students attaining/acquiring knowledge about the serious problems that might affect them, how quickly such problems are evolving, and so on" (Jensen, 2002, p.331).

Table 8. Pattern of integration of issues related to climate change and loss of biodiversity across grade

Issues (analytical categories)		**Grade**				
		9	**10**	**11**	**12**	**Total**
A. Observed and projected changes in climate:					0	
	A1*	5	2	0	2	**9**
	A2	0	2	0	0	**2**
	A3	0	0	0	0	**0**
	A4	0	0	0	0	**0**
B. Observed changes in biodiversity associated with climate change:		0	0	0	2	**2**
C. Projected impacts of climate change on biodiversity and vice versa:						
	C1	0	2	0	1	**3**
	C2	0	2	0	1	**3**
D. Potential effects of activities undertaken to mitigate climate change:						
	D1	3	0	0	2	**5**
	D2	0	0	0	0	**0**
	D3	0	0	0	0	**0**
	D4	0	2	0	2	**4**
	D5	0	0	0	0	**0**
E. Climate change adaptation activities and biodiversity:					0	
	E1	2	0	0	0	**2**
	E2	0	3	0	4	**7**
Total		**10 (8.3%)**	**13 (9.8%)**	**0 (0.0%)**	**14 (12.6 %)**	**37 (8.6 %)**

* These codes (A1-E2) have been defined in the methodology section (see Fig. 2)

Discussion and Recommendations

As institutions for general education, schools have a responsibility to equip their students with the knowledge and commitment to take personally meaningful decisions and action to address the challenges posed by both lifestyle and societal conditions (Jensen, 2002). Achieving this goal requires, among other things, adequate integration of the 'challenges' into the school curriculum.

Grade Nine

- Describe the presence of CO_2, water vapour, and heat in exhaled air *(Dimension I)*
- Compare the composition of inhaled and exhaled air *(Dimension I)*
- Explain the mechanism of gas exchange *(Dimension I)*
- Describe and illustrate the carbon cycle *(Dimension II)*
- Describe plant and animal adaptations *(Dimension I)*
- Explain the importance of planting and growing trees *(Dimension III)*
- Plant and grow trees *(Dimension III)*
- Express willingness to voluntarily participate in community tree planting and growing activities *(Dimension IV)*

Grade Ten

- Demonstrate the importance of CO_2, chlorophyll and light for photosynthesis *(Dimension I)*
- Explain how photosynthesis helps to balance the concentration of O_2 and CO_2 *(Dimension I)*
- Explain how deforestation may lead to CO_2 build-up in the atmosphere and finally to global warming *(Dimension II)*
- Explain the importance of conserving biodiversity *(Dimension I)*
- Explain methods used for conservation of biodiversity *(Dimension III)*
- State the uses of vegetation *(Dimension I)*
- State methods used for conservation of vegetation *(Dimension III)*
- Describe the impacts of humans on vegetation *(Dimension I)*
- Explain the causes of air pollution *(Dimension II)*
- Explain the effects of air pollution *(Dimension I)*
- State the causes of global warming *(Dimension II)*
- Explain the methods used to prevent global warming *(Dimension III)*

Grade Twelve

- Describe water, carbon, nitrogen, phosphorus and sulphur cycles *(Dimension I)*
- Make a diagram of water, carbon, nitrogen, phosphorus and sulphur cycles *(Dimension I)*
- Explain the significance of biodiversity *(Dimension I)*
- Explain the threats to biodiversity *(Dimension II)*
- Explain the status of biodiversity in Ethiopia *(Dimension I)*
- Describe the principles of conservation of biodiversity *(Dimension III)*
- Express a concern towards biodiversity and the need for its conservation *(Dimension IV)*
- Appreciate the importance of plant diversity for animal diversity and vice versa *(Dimension I)*
- Grow trees in a given area *(Dimension III)*
- Express willingness to participate in tree growing activities in ones localities *(Dimension IV)*
- Define carrying capacity *(Dimension I)*
- Interpret a population growth rate curve *(Dimension I)*
- Explain the impacts of rapid population growth on development *(Dimension II)*
- State the measures that should be taken to control rapid population growth *(Dimension III)*

Figure 3. MLCs related to biodiversity and climate change (the *'Dimensions'* in brackets show effort to relate the MLCs with the four aspects of action-oriented knowledge as postulated by Jensen, 2002)

Despite strong policy backing at national and international levels, education related to environmental issues like loss of biodiversity and climate change does not seem to have achieved a full shape yet. The curricula tend to dwell heavily on imparting the science (less often wrestling with ethics) behind such issues (Fumiyo & Selby, 2010). The study reported here reveals that the curriculum guides of Biology for Ethiopian secondary and preparatory schools have integrated a number of issues that could enhance understanding about the significance of biodiversity and consequences of its loss. Issues related to biodiversity have been addressed in one form or the other in all grades except grade eleven. When it comes to climate change, the revised curriculum guides offer little opportunity to integrate the issue. Studies conducted elsewhere also indicate a similar gap with respect to climate change education. Fumiyo and Selby (2010) noted, for instance, that curricula tended to put a marked emphasis on the technological fix with little "recognition of the need to engage learners in openly debating and discussing the roots, personal meanings, and societal implications of climate change scenarios that are likely to play out during their lifetimes, and what needs to be done and achieved of a transformative nature by way of mitigation" (Fumiyo & Selby, 2010, p. 5).

In Ethiopia, curriculum guides serve as a "road map to teachers, students and textbook writers" (MOE, 2009b). This implies, among other things, that issues that have not been included in the guides as units or sub-units will have a little chance, if any at all, to be considered during preparation of students' textbooks, teachers' guides and manuals for practical activities. And where such issues are not 'manifestly' integrated into the curriculum, one cannot expect concrete action planned and executed against loss of biodiversity and climate change. The findings of the content analysis suggest that there is a little cause for optimism with regard to the potential for the existing curriculum to advance efforts to initiate action against climate change in any meaningful way. The curriculum guides offer a very narrow opportunity for teachers to engage in actions related to mitigation of and adaptation to climate change.

It is also important to note that climate change issues had been better addressed in the old curriculum guides than the new. A unit highly related to such issues (entitled *'Biology and human welfare'*) has been removed from the revised guide for grade twelve. Given the current interest in climate change globally and locally, it is quite interesting to see such a scanty representation of the issue in the new curriculum guides. One cannot, of course, expect a single subject like Biology to integrate everything related to loss of biological diversity or climate change. At the same time, this can and should not be an excuse not to find ways in which students get a comprehensive knowledge that empowers them to make meaningful contributions to on-going debates on the multi-faceted nature of such problems as loss of biological diversity and climate change. With this background, the paper strongly recommends the following actions.

- The already existing windows of opportunity in grades nine, ten and twelve be utilized to integrate components of biodiversity and climate change education more adequately; and to add issues which are currently missing.

- Preparation of a comprehensive information "package" that could be used by teachers in their efforts to integrate issues related to loss of biodiversity and climate change, as suggested above. Besides inclusion of relevant content, the 'package' should give hints on teaching and learning methodologies that enhance active learning and action-oriented environmental education (e.g. role-playing, debates, fieldwork, place-based learning, etc.).Such a "package" can also be used by curriculum designers when the next revision of the curriculum guides and textbooks takes place. The "package" can

be prepared by the Environmental Education Department at Environmental Protection Authority or Addis Ababa University or the Ministry of Education itself.

- With regard to issues that are apparently too broad to be fully integrated into Biology (e.g. weather and climate), an interdisciplinary collaboration is highly recommended. For instance, a high level of complementarity exists between the curricula of Biology and Geography. A similar assessment on the curricula for Geography indicates that the scientific bases of climate change are well addressed. One could thus see a great opportunity for forging and/or strengthening horizontal collaboration between teachers of Biology and Geography at secondary and preparatory levels. This could also benefit Geography students and teachers as the curricula of Biology seems to be much richer with regard to natural resource conservation and management.

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Etiyopya Okullarında Yer Alan Biyoloji Müfredatı Konularından İklim Değişikliği Ve Biyolojik-Çeşitliliğin Yok Olması: Eylem Yönelimli Çevre Eğitimine Yönelik Çıkarımlar

Genel eğitim kurumları olan okulların, hem kendi yaşam tarzları hem de sosyal şartlarında karşılaştıkları sorunlara yönelik anlamlı kararlar alabilecek ve eylemde bulunabilecek donanımda kişisel sorumluluk sahibi bilgili ve adanmış öğrenciler yetiştirmede sorumlu olduğuna inanılmaktadır. Bu amacı başarma, diğer hususlarla birlikte, sorunların okul müfredatına uygun bir şekilde entegrasyonu zorunluluğunu gerektirmektedir. Bu çalışma, Etiyopya hazırlık ve ortaokul biyoloji müfredatına iklim değişikliği ve biyoloji çeşitliliğin yok olması konularının entegre edilip edilmediği ile ilgili araştırma sonuçlarını açıklamaktadır. Bu amaçla temel teknik olarak içerik analizi yapılmıştır. Bulgular, gözden geçirilen müfredatın biyolojik çeşitliliğin önemi ve bunun yok olmasının sonuçları ile ilgili bir çok meseleyi entegre ettiğini ortaya koymuştur. Biyolojik çeşitlilikle ilgili bir çok mesele tüm sınıflarda (11. sınıf hariç) bir şekilde ele alınmıştır. İklim değişikliği konusuna gelince gözden geçirilen müfredat bu meseleyi müfredata entegre etmede olanaklar çok az şekilde kullanmaktadır. Bu yüzden bu çalışma, somut bir eylem planı olmadan ve bu eylem planı uygulanmadan müfredata entegre edilme konusunun tartışmalı olduğunu ortaya koymuştur. Çalışma disiplinler arası bir yaklaşımla ve/veya mevcut programın revizyonu yoluyla gözlemlenen bazı sınırlılıkların yeniden ele alınması çağrısında bulunmaktadır.

Anahtar Kelimeler: Eylem, biyolojik çeşitlilik, iklim değişikliği, içerik analizi, müfredat, çevre eğitimi