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باب اللغة الإنكليزية

Incorporating the Precious Home Earth Education into the English Language Curriculum

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Abstract:

The schools that make the greatest contribution to life in the next generation will be those schools that are related to the world community, our Earth. Yet, they are firmly anchored in their communities. This article is an exploratory and suggestive rather than comprehensive and definitive. The qualitative approach is adopted in the study. It tackles methods in which students must be educated in loyalty to the highest ideals of the world community, the planet Earth. It serves a special function in the area of education for international understanding. The paper examines a variety ofways in which the tenets of Earth can be included into the English language curriculum of different cycles. Three English language teachers of four cycles: cycle one,two, three and four were interviewed and observed. They are teachers of two public schools in Zahle: Al BerdawnyPublic School and Houch Al oumaraSecondary Public School. The paper tries to suggest that teachers should adopt an approach in promoting Earth education by implementing student-centered approach and by engaging students in practical activities such as field trip that would give them opportunities to demonstrate the tenets of Earth. It explores the best ways to develop world-minded school students.

Key words: Earth Education, cycles 1, 2, 3 and 4, International understanding, English language curriculum

ملخص

المدارس التي تقدم أكبرمساهمة في الحياة في الجيل القادم ستكون تلك المدارس المرتبطة بالمجتمع العالمي، أرضنا. ومع ذلك، فهم يرتقون بثبات في مجتمعاتهم. هذه المقالة استكشافية وموحية أكثرمن كونها شاملة وحاسمة. تم اعتماد النهج النوعي في الدراسة. إنه يعالج الأساليب التي يجب أن يتعلم بها الطلاب الولاء للمثل العليا للمجتمع العالمي، في كوكب الأرض. وهي تؤدي وظيفة خاصة في مجال التعليم من أجل التفاهم الدولي. تبحث الورقة في مجموعة متنوعة من الطرق التي يمكن بواسطتها

تضمين مبادئ الأرض في منهاج اللغة الإنجليزية لحلقات مختلفة. ثلاثة من مدرسي اللغة الإنجليزية من أربع حلقات: الحلقة الأولى، الثانية، الثالثة والرابعة تمت مقابلتهم وملاحظتهم. وهنّ مدرسات في مدرستين حكوميتين في زحلة: مدرسة البردوني الرسمية وثانوية حوش الأمراء الرسمية. تقترح هذه الدراسة على المعلمين تبني نهج تعزيز تعليم كل ما يتعلق بكوكب الأرض من خلال تطبيق نهج يركز على الطالب وإشراك الطلاب في الأنشطة العملية مثل الرحلة الميدانية التي من شأنها منحهم فرصًا للتدليل على مبادئ الأرض. وكما تستكشف أفضل الطرق لتطوير طلاب المدارس ذوي التفكير العالمي.

Introduction:

The story of the Earth can be a thrilling one to children of all ages. There are somany chapters in it that are filled with mystery and adventure that almost every student should find it interesting.

There is the story of the formation of this planet and the history of the seemingly endless period in which the Earth was the home of animals whose fossil skeletons we store in museums today. There is the mystery of the movement of the Earth as it revolves around the sun and moves on its own axis to give us day and night. There are the colorful and tragic stories of the men who dared to declare the Earth round, defying the so-called wise people of their day, and of those who ventured into the great unknown and discovered uncharted continents, oceans, mountains, and even groups of people with civilizations at least as advanced as theirs (Fullard, 2005).

And still the quest goes on for more data about the world, with expeditions to the Arctic and Antarctic, with explorations through giant telescopes, with diving into the depths of the oceansto learn about there, and with scientific experimentation and speculation about flights to Mars or the Moon or other planets (Gough, 2005).

Most important is the history of the Earth as the home of the man.This is a continuous account of man on the move, exploring new parts of the Earth and colonizing them. It is likewise the story of how man has tamed the elements, domesticated animals, learned to plant on the surface of the globe, and to mine within it (Savelava et al., 2010).

The Earth has fed man and bled him. He has conquered it to some extent, learning how to ride across its waters, to tunnel through its mountains, to dig canals, to terrace the Earth, and to bridge its streams and rivers.

Yet, man has wasted the Earth, too. Millions of acres of desert and denuded hillsides are the monuments to his pillage and destruction. Today he is paying a huge price for the folly of his ancestors and his own waste. Meanwhile, he is trying to bring back to life vast waste lands, seeking new sources of food from the air, from the sea, and from the laboratory, and trying to double or triple the present production of food by new and better ways of growing crops (Gough, 2005).

This Earth is man's workshop and his laboratory. And it is his playground, too. He rushes to the mountains or the seashore to escape the heat and the humidity. He dons skis to glide over its surfaces. He swims in its waters and plays on its land. There is pleasure on this giant ball as well as work.

In telescopic form, this is the world which we are permitted to help children to discover. Parents and teachers are their guides, but the excitement of discovery must be theirs (Shumba et al., 2008). There is work involved in equipping these young explorers, but there is pleasure, too, for, those who gladly teach.

This article investigates different ways of incorporating Earth education into language curriculum in the four cycles.

1- Cycle One and Two

A group of young children has been down to the seashore for the day. They have waded in the ocean, splashed water over each other, scooped sand with tiny shovels into bright pails, collected all shapes and sizes of shells and curious debris from the sea, built little canals to let the water trickle into its channels, and made giant castles with their hands-all too soon to be destroyed.

Another group has taken part of a beautiful autumn day to walkthrough tile woods, to scuff through the fallen leaves, to pick up some of the brightest castaways from the trees, or to hide tiny bits of stone wood in their pockets or purses. Perhaps they have stopped by a stream to hunt the fossils which the water has loosened from little rock animals.

Still another group has taken a trip through a botanical garden or park and has enjoyed feeding the squirrels or looking at the flowers.

Or another group of children has visited the planetarium and marveled at the story of Earth and sky. In such ways, children need to discover the Earth - through water, sand, leaves, fossils, flowers and stars. These are happy experiences for them, highly emotional in nature, shared with their peers, their friends, and their families.

It will be years before they understand the solar system, but they can learn early in life that they live on a large ball called the Earth and that it spins in the air like a top. They can learn that night and day have something to do with the spinning of the Earth. They can see the Earth and feel it and turn it in a cradle globe or a reproduction in the form of a balloon (McKeown, 2002).

They can learn from the fossils or the rocks they bring to school that this Earth is old and that the sand in their sandbox was once like the rocks. By rubbing stones together they can actually see how the sand was formed (McKeown, 2002).

By direct experiences, they can learn about the various bodies of water called oceans, rivers, lakes, or streams, depending upon where they live. They may even learn that the blue parts of the globe represent water and the green and brown parts usually refer to rich Earth and rocky lands.

By planting seeds in rich, black Earth and in sandy, rocky soil they can discover that there are different kinds of soil and that most plants grow best in rich Earth with plenty of sunshine and water. Even in crowded city schools, young students can learn somethingabout the sun, soil, and water from the seeds planted in milk cartonsand carefully tended over a period of weeks (Allen, 2005).

Young children need to experience the Earth by playing in sand, soil, and even mud. They need to feel it and enjoy it. Eventually, they need to know that it is valuable as well as enjoyable and that people plant trees to save it from going down the streams and rivers to the sea (Allen, 2005).

Young students can also learn something about the Earth as a giant storehouse. A trip to a coal mine or a silver, lead, or zinc mine is a possibility for some. Where such trips are impossible, films, films - strips, pictures and others can provide vicarious experiences (Barboza, 2000).

Young children can bring to school samples of things which grow under the ground or above the Earth's surface. Gradually the concept of the Earth as a place full of valuable things can take on

meaning. It would begin to mean the black rocks called coal which children obtain from the custodian or from home, the carrots and radishes they have dug from their own garden, or the tomatoes which they shared with at lunchtime (Bourn, 2005).

The resources for carrying out such a program are ample. The great out-of-doors should be the science laboratory for children. In large cities, the parks and zoos, the botanical gardens, plus occasional small plots of ground or window boxes must suffice. The planetarium can be visited by older primary grade children (Cloud, 2005).

Young children should be introduced to the idea of the balance in nature by their own aquarium and terrarium as well as by stories about how the Earth replenishes itself and how air, water, fish, animals, and other parts of the Earth aid each other (Heimlich, 2007).

They should have a globe somewhere in the room and have some elementary instruction about maps, learning a few of the simple symbols which they will use all their lives. In this connection, teachers will want to have a suspended globe or cradle globe.

Some day an enterprising school can provide a physical map of the world in concrete on its playground so that primary school children can become acquainted with some of its major features through play on it, before they actually study it.

Young children should have pets at home or at school, cats or dogs or tropical fish. Where it is impossible to keep them at schoolover long periods, they can be brought in for a day. Where children cannot have pets at home permanently, they can have them for short periods of time. A promising practice is the lending library of pets from zoos, with two weeks as the best length of time for children to "borrow" them. In extreme cases, children can at least observe and handle pets at zoos or in the few children's museums whichkeep live animals (Edwards, 2000).

Gardens can give children more meaningful experiences about the sun, soil, and water than a host of audio-visual experiences. Where home and school gardens are out of the question, window boxes or small dishes of shallow water for sweet potatoes, lima beans, carrot tops, or avocado seeds can be used. Children can also observe cloud formations, examine water in its different forms, observe the sun and stars, and learn about the Earth in other ways (Eilam & Trop, 2011).Trips should be made to the zoo, the circus, the park in a city, and to a wide variety of places in smaller towns and the country (Eilam & Trop, 2011).

Of course, there should be paints and brushes and clay for children to reproduce what they have seen. Whether their reproductions are scientifically accurate does not matter; they should paint what they have seen and give teachers and parents clues as to what to help them look for another time (Gadotti, 2010).

Through these and other experiences, young children can learn about the world in which they live, how it affects them and other people, and how they can adjust to it and use it. Also, they can learn to regard it with awe and wonder, qualities too often neglected in our current curricula (Sterling, 2010).

2- Cycle Three

Many of the topics just mentioned can be pursued farther and further in cycle three. The Earth can be explored as a part ofthe solar system, with a clearer idea of day and night and the seasons.Children

can learn that mostof the world is water and that men live only on a very small part of the land surface. Longitude andlatitude need not be stressed, but they can be introduced as ways of helping people to locate places on the Earth and as a part of the necessary knowledge.

Children in this grade can grasp the concepts of how the Earth affects man and how man has changed and used the Earth's surface.The stories of harbors, bridges, subways, tunnels, and airports can be told and read. Students can learn a little, too, about how man can utilize the soil.

Maps are important at this stage of development. The concept of a continentand such land and water forms as islands, peninsulas, bays, seas, lakes, and rivers can bestudied. Children find it fascinating to explore some of the major rivers of the world, such as the Nile, the Tigris-Euphrates, the Yellow, the Congo, the Indus, the Volga, the Amazon, the Danube, the Litani river, and some of the rivers in Lebanon, learning how these have been the highways of manfor centuries. The major mountains of the world can be studied in an elementary way and maps of various kinds made of them, helping children to discover how they have been barriers betweenpeoples, whether they are studying the Himalayas or the Andes, to take two outstanding examples. Stories of the scaling of the highest peaks often prove fascinating to young children of this age (Sauvé, 2017).Finally, they can make a simple study of conservation and its importance in preserving the resources we have and in replenishing our supplies where that is possible (Cloud, 2005).Considerable attention should be given to the ways in which man has used the Earth as well as how he has been affected by it.

The experiences by which these concepts are introduced can be many and varied. In order to understand the Earth as a part of the solar system, children should construct their own miniature planetariums. They may want to study the shadows in the school yard or playground. They may be able to visit a nearby observatory or planetarium and to purchase their own small telescopes. The folk tales of the stars can be used effectively at this point as part of the language arts program of a school (Scott, 2016).

The construction of a large globe, made with wire and paper or canvas, can become a major center of interest. An elementary school can start, with each successive class adding some major geographical features to their globe. Carried on as a class or school project, this can be a memorable learning experience (Scott, 2016).Where large reproductions of the world are available in the community, field trips should be made to them.

The movements of man to the most suitable parts of the Earthcan be studied as a part of a unit on the Earth or as an integral part of any science and social studies program. Children will soon discover that the temperate zones have become the major abode of man. Some of them will be interested in tile ways in which scientists are exploring the possibilities of making other parts of the globe habitable (Sterling, 2010).

Almost any part of the Earth can be used to illustrate how theEarth has affected man and how he has used and changed it. Norway, for example, is a mountainous country where people have learned to live on the fringes of the fjords and to take their livestock into the mountains in the summer. But these Norwegians have also learned how to make electric power from their mountain streams and to put out to sea, from the days of the Vikings to the present (Carvalho et al., 2009).

In The Netherlands the people have made their homes of brick, using the clay and sandy soil which

was available around them. They have also discovered that their sandy soil is good for vegetable flowers, fruit trees, and grazing and they have built their economy around these products. Since there is wind most of tile time, they have used it until fairly recently for making power through wind mills. And since the surface of the country is flat and money not too plentiful, they have resorted to bicycles for transportation. Similarly, they have learned to drain the swamps and to build dikes to increase their land (Davies, 2004).

As pupils study different nations or find examples of these major concepts from various parts of the globe, they can learn about terracing in China or the Philippines and the turning of deserts into fertile land in Lebanon, India, and Pakistan. They can study canal building in Egypt and Panama, learn about the tunnels in Switzerland and Italy or find out about bridges in many parts of the world. Maps of many kinds can help children to learn about the continents, the major mountains, the various bodies of water, and the fertility of soil in different parts of the world. At this stage in their development young children can also begin to learn where the major resources of the Earth are located and how man has used them for many purposes (Burde, 2006).Some children may find an elementary study of geology interesting at this point.

The Importance of firsthand, concrete experiences and of experiments cannot be emphasized too much. Books, audio-visual resources, and trips to farms, research centers, weather stations, and similar places can also be rich experiences (Burde, 2006).Fortunately, there is considerable material for the middle-grade reader on the Earth as the home of man and other living things.

3- Cycle Four

By the time students reach the upper grades they should be able to understand better many of the concepts already mentioned and add a few more complicated ones.

The ways in which land and climate have affected human beings can be illustrated in a variety of parts of the world, with special reference to the river valleys of the Nile, Tigris-Euphrates, Indus, and Hwang-Ho, where it is believed that early civilizations began.Mountains as the great barriers to contacts between people can receive fuller attention, especially as pupils study the history of South America, China, India, and Italy (Feinsinger et al., 2007).

The effect of geography upon political life can also be introducedat this stage. The ways in which the geography of Switzerland has affected its policy of neutrality, the ways in which the location of the United States has influenced its political isolation until recent times, and the long effort of Russia to secure warm water ports are three striking examples of a concept which can be illustrated with many examples (Carlson, 2005).

At this stage, children can begin to learn how the struggle for raw materials around the world has led to imperialism and colonialism. Examples can be drawn easily from current events, whether it is Iran, Saudi Arabia, Indonesia, or Thailand which is in the news at the moment.

Students need to learn how dense the population of some parts of the world is and how that affects world affairs, from the three and a half million persons on the small island of Puerto Rico to the seven hundred million on the relatively poor island of Japan (Rozzi et al., 2006).

The story of how people today in many parts of the globe are building dams and irrigation projects

should be a thrilling one, giving pupils a sense that the world is moving in the right direction to give people everywhere more to eat and higher standards of living.

Closely linked with this are the efforts to find new sources of food: by increasing the rice supply through better farming methods as devised by the Japanese, by supplying fertilizers to the farmers as is being done on a large scale in India, by salvaging the deserts as is being done in Pakistan, or by bringing submarginal lands into use. This can be tied in closely with developments in the United States, such as the planting of the tree belt in the Middle West, the current use of contour plowing, and the development of hybrid corn (Bourn, 2005).The work of the Food and Agricultural Organization of the United Nations and the research projects of UNESCO in the use of arid lands will interest some pupils.

Because of the tremendous importance of atomic energy, a simplestudy of it can be made, with particular emphasis upon its peacetime uses.

The topic of the Earth as the home of man is a large one, but it should be fascinating for all grade levels. A comprehensive and cumulative curriculum, based upon the needs and interests of children and society, can develop the major concepts mentioned effectively, using the wide variety of resources and experiences now at hand for learning.

4- Purpose of the Study

The paper is written with the aim of encouraging teachers to expose their students to practical and meaningful activities by implementing a student-centered approach to incorporate Earth education into the English language curriculum.

5- Methodology

The author of this paper has painstakingly provided different methods of fostering the tenets of the Earth. Different approaches were suggested. Each section in the review of literature acts as a guide for classroom teachers. The methods were carefully selected, taking into cognizance its relevance and interest to students for the different cycles. In developing the three sections for the four cycles, the author has made sure the approaches selected were rich in local content and suitable for the background of students in the public and private schools in Lebanon.

Mainly, the data and findings reported here are drawn from a semester long study of three teacher's attitudes and perceptions of the inclusion the Earth education in their English language curriculum. This paper describes the results obtained from the qualitative data analysis. The author spent one year in three teachers' classrooms gathering detailed information on their experiences with the approaches they adopted to integrate the Earth education mainly through interviews and classroom observation (Appendix A and Appendix B).

6- The Research Questions

Two research questions guided the analysis of the data for this paper:

a. What are the three teachers' perceptions of incorporating the tenets of the Earth into the students' education?

b. What are teachers' teaching practices to incorporate Earth education into their English language curriculum?

7- The Two Schools' Setting

The study was conducted in two public schools in Zahle. The main motive for choosing Zahle is based on the importance of the environment of that area and it is being the city of the researcher. The schools were chosen so that the first one, Al Berdawny Public School, is a primary school (cycle one and two), and the second one, Houch Al Oumara Secondary Public School is a secondary school. Although the schools were different, they are similar in some aspects like class size, availability of teaching and learning resources, and implementing the Lebanese curriculum.

8- Teacher Participants

Participants for the qualitative inquiry were recruited from of all teachers whose courses were scheduled to enroll many tenets of the Earth in their Lebanese English curriculum. Three teachers agreed to participate: Rebbeca, Daisy and Pauleen. Most importantly, they took into consideration the suggested activities in the literature review for each cycle they are teaching. Their selection was influenced by the aim of the study and also on the aspect of trying to get variations in experiences as far as possible. The class level the teacher taught was also taken into consideration. Rebecca is a cycle one and two teachers in Al Berdawny Public School. Daisy is teaching cycle three in Houch Al Oumara Secondary Public School. Pauleen is teaching cycle four in the same secondary school. The professional qualifications of the teachers were not considered as a criterion for selection because almost the three participants had the same qualifications.

9- Data Collection and Analysis

Data for this study was collected using the mixed approach methods (Creswell, 2008) and it included interviews and lesson observations (Appendix A and Appendix B). Through interviews the researcher was able to obtain the teachers' opinions, points of view, values, feelings, attitudes, perceptions and practices regarding the incorporation the Earth education into the English language curriculum. Through observation, she could see what teachers actually do to obtain a deep understanding of what they say and do about the issue being investigated. To understand how the experience of incorporating the tenets of the Earth into the English Language curriculum by each participant, she spent one academic year with the teachers. She was familiar with the two school's sites and personnel because she was a counselor.

Before the observation began, the participants and the researcher met for an initial interview. This interview lasted 30 to 40 minutes and was guided by a set of questions designed to get information about teachers' experiences, their attitudes and accommodations (Appendix A). All interviews were recorded for analysis. The first interview was followed by weekly classroom observations. The researcher observed the lessons and developed a written account of how the lesson was conducted and all that happened in the class. After each observation, she spoke with teacher participants asking questions related to the observation (Appendix B). The findings can be valid and reliable because the

participants were not taken out of their context.

In order to analyze the data, the researcher read it from all sources (transcripts, observations, field notes, and documents) to get "a sense of the whole" (Hatch, 2012, p.181).

In addition, she recorded her impressions and developed preliminary interpretations. She was aided in her organization and display of data by NUD*IST (Stokes, Davis, & Koch, 2005; Gahan & Hannibal, 2015), a qualitative software program. Through the process of coding, she identified what she considered to be essential features and the ways in which the features interacted. For example, as analysis progressed the three teachers' notions of the best practice to make students aware of the importance of the Earth through teaching its tenets according to some of the methods suggested in the literature review for each cycle in this paper became clearer. For a measure of trustworthiness, she asked each teacher participant to check a draft summary of her interpretations and to provide feedback.

10- Teachers' Perceptions of Incorporating Earth Education into the English Language Curriculum

The first question aimed at finding out how teachers perceive and understand the ways and concepts suggested for each cycle in the literature review. They were asked what the Earth means to each one of them. Rebecca described it as a physical setting and the other two as a socially constructed setting. Rebecca said, "Earth is the total of all the physical things that surround human beings." On the other hand, Pauleen said, "I can say that man or people are part of the Earth because he is one of the living things."

The majority of the respondents described Earth education as education about the environment. The answers were only related to the cognitive and awareness perspectives of Earth education. Rebecca was concerned with sustaining lives because she said that we need knowledge about the Earth to sustain our lives. Daisy talked about knowledge about the Earth in terms of security. She argued that some of the objects on Earth are dangerous.

Rebecca added that Earth education is education that makes an individual aware of the environment. This awareness here refers to an individual's ability to recognize, feel or be conscious of events, patterns and even objects in his/her surroundings. Pauleen argues that because the Earth is something which is always there, people may not be aware of it, so Earth education is a means of developing awareness of the environment among the people. The aforementioned can be illustrated in the following:

"Earth education is education that enables an individual to be aware of his/her environment. Although the Earth is always there, we might not be aware of it. We take it for granted!" (Rebecca)

"As I understand, Earth education is education that enables us as human beings to know our environment and develop an awareness of the different things which are in our environment. Developing awareness is important because it helps an individual know the state of the environment." (Pauleen)

"Earth issues motivate students. Learner's motivation increases if they are studying something rather than just studying language."(Daisy)

The awareness of the three teachers of the importance of the Earth education is lucid. To find out how it is implemented, the second research question investigates the teachers' teaching practices in their incorporating Earth education.

11- Teachers' Teaching Practices in Teaching Earth Education

The second research question is concerned with the teachers' teaching practices in incorporating Earth education. This research question spotlights the teachers' ways in which they integrate Earth education in teaching, and the teaching methods used. The interviews were followed by a few lesson observations to see how teaching was actually being carried out in the classroom.

The three teachers were encouraged to discuss how they teach Earth education. They admitted that there is no uniform way in which they can include Earth education because the approaches differ. The three said that they used it as a teaching and learning resource. They all added that they teach Earth education when they teach structure, vocabulary, comprehension, poetry and composition skills. In addition, language teaching has no defined content. Earth issues could provide a rich source of content. This is clearly stated in the following:

"When teaching, for example, reading aloud or for comprehension, I refer to a passage about Earth. When I come across vocabulary which is related to Earth like trees, bushes, etc., I use it to teach. Using the passage and the vocabulary, you can discuss with the pupils the uses of trees, importance of taking care of trees and bushes on Earth, and what will happen if we cut down the trees or clear the bushes." (Daisy)

"I include it in composition writing, like "Write a composition on the benefits of forests" or I ask the pupils to compose poems with Earth messages." (Pauleen)

"I make the students learn vocabulary from the things on their Earth, make sentences which have messages and read passages about Earth for reading comprehension. For example, in teaching the use of "because" and "since" they would make sentences like, "the maize crop was poor because there was no rain" or "He got sick because he drank dirty water." (Rebecca)

The teachers' statements show how Earth education texts and information can be used in developing language, while at the same time helping the learner develop Earth knowledge.

12- A Lesson Observation:

A lesson observation took place in cycle two. Rebecca was teaching a reading comprehension passage with the title, Water Pollution.

By using the questioning technique, the teacher started by asking the students to mention the different uses of water in their homes and school. They answered that they used water for drinking, washing, cooking, for irrigation and for keeping fish. The second question was about the places where there is water. The students talked about places like rivers, lakes, ponds, oceans, springs and rain.

This was followed by group work asking students to discuss the different activities which can make the water dirty. Then each group had its own presentation about the ways of making water polluted like dumping waste in the river. Finally, she gave them an assignment to find out the dangers of making water polluted.

13- Reflection on the Lesson

After the observation, the teacher and the researcher reflected on it. The researcher asked her about her lesson and whether she was successful in incorporating Earth education. Rebecca answered by saying that:

"I think I was successful because the topic itself was related to Earth education as water is a part of Earth. Moreover, it has evident personal relevance for lives of the learners."

When the researcher asked her about taking students outdoors, she responded telling the researcher that she may face the problem of their being young and many and she cannot manage them all by herself. She told her that she always tried to link the topic to the students' daily life.

The above description is presented as an example of how teaching and learning usually take place while incorporating Earth education. Although what is usually integrated about Earth is not clearly stated in the English language curriculum, teachers still try to relate what they are teaching to what surrounds them especially Earth and its components and their daily lives.

14- Teachers' Perceptions of the Methods They Use in Teaching Earth Education

The three teachers expressed the same opinion that Earth education teaching methods should make the learners participate through learning by doing. This is directly related to student-centered approach. This is clear in the following:

"The methods which are suitable for the teaching of Earth education are those which give the individual student the opportunity to do things for himself or herself. It is by doing that the student develops different skills. For example, we insist that they plant trees so that they can get fruit, firewood, and timber for building. If we just tell them without making them do it they will not be able to grow even a single tree when they go back to the community after finishing school." (Rebecca)

They emphasized the participation of the learners by doing when teaching about Earth to help them develop skills which they can use in their daily lives. Consequently, this would enhance the thinking skills of the students.

15- Discussion of the Results

The main purpose of the study was to investigate three English language teachers' perceptions of the incorporation of Earth education into the English language curriculum. The discussion is done in the light of the two research questions and is linked to the literature review. The study was qualitative in nature. The data was collected through interviews and observations.

The findings of the study partly reflect the definition which is education about, in and for the Earth. It is partly because the teachers' perceptions of Earth education were limited to education about the Earth, which is mainly concerned with getting factual knowledge about the Earth. Very little emphasis was given to education for the Earth which is concerned with the development of skills and attitudes towards Earth. None of the teachers described Earth education as education on Earth, which refers to Earth as a learning platform where learners can engage in observations and investigative activities. This could be because most of the teaching and the learning is conducted in the classroom through the propagation of knowledge (Carlson, 2005).

In this paper, the three teachers consider Earth education as education which is focused on helping learners develop knowledge about Earth, and in most cases, they referred to the biophysical component Earth only. The three teachers' perceptions on the incorporation of Earth education into the English language curriculum revealed that they think that the teaching of Earth education is important, emphasizing that the knowledge would help the students cope with their daily life (Colchado, 2003; Davies, 2004). This positive attitude indicates that the three teachers are ready to teach it if they get support. Generally, the three teachers insisted that Earth education should be taught in all cycles. It should be incorporated in the English language curriculum.

With respect to the methods used, the three teachers pointed out that they usually use student-centered methods during their teaching to enhance thinking, cooperation and Earth knowledge (Galang, 2001; Ernst & Martha, 2014). The teachers emphasized the importance of all the methods suggested in the literature review of this paper.

The three teachers' collective concern is that Earth education opportunity in English language curriculum would be denied to students because they lack hands-on activities and field trips in their schools (Gayford, 2003; Guenewald, 2015). From their knowledge of their educational institution, the teachers would declare that students are eligible of Earth education only after they are involved in an enjoyable, funny, responsible and edifying learning experience and when they use activities that take a positive approach and focus on what individuals can do to help (Hughes, 2002; Powers, 2004; Shumba, et al., 2008; Padilla, 2011). Despite their varying levels of comfort with this reality, all three teachers would continue to teach, assess and grade Earth education to put it on the English-only pathway to educational opportunity.

16- Implications

The findings of this study reveal how two schools and three teachers tried to incorporate Earth education into the English language curriculum. The findings are local and particular to these teachers and the two schools. However, implications drawn from this study may provide insight into other schools in other contexts and into ideas about Earth education in general.

This study points to a need not only to rethink traditional approaches for Earth education, but, perhaps to rethink educational opportunity itself. For fostering Earth education, all students must have access to opportunities that are not just real, but authentic and participatory. Moreover, teachers need to change their orientation and thinking mentality to accommodate new changes in the curriculum. They need to change the way they think about themselves and about Earth. They need to start doing the things that can preserve the Earth as well as promote peaceful co-existence.

Most of the English language teachers do not possess the knowledge to teach Earth education. How can they disseminate and implement knowledge that they do not have? This situation suggests that there is a need for teacher education to design appropriate training programs, both pre-service and in-service, that can help teachers in the teaching of Earth education.

Conclusion

Some people say that the world is growing smaller and in a sense that is true. Yet, in another sense,

the world is constantly growing larger. One can no longer be a competent citizen, parent, or teacher merely by knowing about one's home community, state, and nation. One must also know a great deal about the world, our Earth.

Ours is a world of crisis and it may continue so for a long time to come. The only thing which seems certain about the world at times is change, and even the tempo of change is accelerated.

It is no simple task to introduce students to this vast, complicated, chaotic, changing world community, our planet Earth. It cannot be done by adding another subject to the already overburdened curriculum; it must be done by having the world dimension added to all phases of existing subjects. It cannot be done by the social studies field alone; it must be done by work in all fields.

The little that parents and teachers can do may seem trivial to them. In such moments it may be well to remember the truth so simply stated in the African proverb: "A river is made great by its little streams."

Appendix A
Interview Guide for Teachers

School: ……..……

Cycle: ……..

Gender: ……

Teaching experience:……..

Education Level:……

Previous training in the Teaching of Earth: ……

Research Question 1: What are the three teachers' perceptions of incorporating the tenets of the Earth into the students' education?

1. What do you understand by Earth?
2. What do you understand by Earth education?

Research Question 2: What are teachers' teaching practices to incorporate Earth education into their English language curriculum?

1. How do you include Earth education content in your daily teaching?
2. What methods do you use in teaching the tenets of Earth in your subject?

Appendix B
Lesson Observation Guide

A. Teachers' personal information

Subject:…….

Cycle:……..

No. of Students:…….

Gender: ……

Age: …….

Teacher's experience: …….

Educ. Level ……

Previous training in the teaching of Earth education:

…….....

B. Details of the lesson

Topic:

Was the topic related to Earth education?

If not, how were Earth tenets addressed in the topic?

Earth education content:

What was the Earth education content brought up in the lesson?

Knowledge of subject matter:

How knowledgeable was the teacher about the Earth education content that she taught?

Involvement of students:

How did the teacher engage the students in the lesson?

Teaching/learning materials:

What kind of teaching/learning materials did the teacher use?

Assignments:

What kind of assignments did the teacher give to the pupils?

Were they related to Earth tenets?

Reflection questions:

a. To what extent do you think you have been successful in integrating Earth education tenets in your lesson?

b. Do you use outdoor experiences to teach your lessons?Give reasons for your answer.

References

1. Allen, I. (2005). Embarking on the decade for sustainable development: A Swaziland View. Applied Environmental Education & Communication, 4(3), 283-287.
2. Barboza, N. (2000). Educating for a sustainable future. Prospects, 30(1), 71-85.
3. Bourn, D. (2005). Education for sustainable development and global citizenship. Applied Environmental Education & Communication, 4(3), 233-237.
4. Burde, D. (2006).Education in crisis situations: Mapping the field. Washington DC: Creative Associates Incorporated and Care.
5. Carlson, C. (2005). Improving the delivery of health and education services in difficult environments: Lessons from case studies. London: HSRC
6. Carvalho, C., De Filho, N., Leal, W.,& William, H. (2009). An analysis of the problems of developing environmental education in protected areas. The Environmentalist, 18(4), 223-229.
7. Cloud, J. (2005). Some systems thinking concepts for environmental educators during the decade of education for sustainable development. Applied Environmental Education & Communication, 4(3), 225-228.
8. Colchado, J. (2003). Engaged institutions: Impacting vulnerable youth through place-based learning. Rural School and Community Trust. Available online at: http://www.ruraledu.org/articles.php?id=2081
9. Creswell, J. (2008). Educational research: Planning, conducting and evaluating quantitative and qualitative research (3rd edition). Upper Saddle River, New Jersey: Pearson Education, Inc.
10. Davies, L. (2004). Education and conflict: Complexity and chaos. New York: Routledge.
11. Edwards, B. (2000). Educational reform and sustainable development. Prospects, 30(1), 57-70.
12. Eilam, E., & Trop, T (2011). ESD Pedagogy: A Guide for the perplexed. Journal of Environmental Education, 42(1), 43-64.
13. Ernst, J., & Martha, M. (2014). The effects of environment-based education on students' critical thinking skills and disposition towards critical thinking.Environmental Education Research, 10(4), 507-522.
14. Feinsinger, P., Margutti, L., & Oviedo, R. (2007). School yards and nature trails: Ecology education outside the university. Tree 12 (3), 115-120.
15. Fullard, D. (2005). Biodiversity education at a Natural World Heritage site: Kirstenbosch botanical garden. Roots, 2(1): 3.
16. Gadotti, M. (2010). Reorienting education practices towards sustainability. Journal of Education for Sustainable Development, 4(2), 203-211.
17. Gahan, C., &, Hannibal, M. (2015). Doing qualitative research using QSR NU'D*IST. Thousand Oaks, CA: Sage.
18. Galang, A. (2001). A post-modern approach: Environmental education. Miriam College

Faculty Research Journal, 20 (4),65-98.

19. Gayford, C. (2003). Participatory methods and reflective practice applied to research in education for sustainability. Canadian Journal of Environmental Education 8(1), 129-142.
20. Gough, A. (2005). Sustainable schools in the UN Decade of education for sustainable development: Meeting the challenge? Southern African Journal of Environmental Education, 23, 48-63.
21. Guenewald, D. (2015). Accountability and collaboration: Institutional barriers and strategic pathways for place-based education. Ethics, Place and Environment 8(3), 261-283.
22. Hatch,J. (2012). Doing qualitative research in educational settings. Albany, NY: State University of New York Press.
23. Hughes, R. (2002). Planet Earth. New York: Alfred A. Knopf.
24. McDuff, M. (2016). Conservation education and outreach techniques.Oxford, UK: Oxford University Press.
25. McKeown, R. (2002). Education for sustainable development toolkit. Waste Management Research and Education Institution. Available online at: http://www.esdtoolkit.org/about.htm
26. Padilla, M. (2011). Environmental education to environmental sustainability. Educational Philosophy and Theory, 33(2), 217-230.
27. Powers, A. (2004). An evaluation of four place-based education programs. Journal of Environmental Education, 35(4), 17–32.
28. Rozzi, R., Massard, F., Anderson, C., Heidinger, K. &Silander, J.Jr.(2006). Ten principles for biocultural conservation at the southern tip of the Americas: The approach of the Omora ethno botanical park. Ecology and Society, 11(1), 43-77.
29. Sauvé, L. (2017). Environmental education between modernity and postmodernity: Searching for an integrating educational framework. Canadian Journal of Environmental Education, 4(1), 27-56.
30. Savelava, S., Savelau, D., & Cary, M. (2010). Practicing ESD at school. Journal of Education for Sustainable Development 4, (2), 259-269.
31. Scott, W. (2016). Judging the effectiveness of a sustainable school. Journal of Education for Sustainable Development, 3(1), 33-39.
32. Shumba, O., Kasembe, R. Mukundu, C., & Muzenda, C. (2008). Environmental sustainability and quality education: Perspectives from a community living in a context of poverty. Southern African Journal of Environmental Education, 25, 81-97.
33. Sterling, S. (2010). Learning for resilience, or the resilient learner? Towards a necessary reconciliation in a paradigm of sustainable education. Environmental Education Research, 16(5), 511-528.

Stokes, M., Davis, C., & Koch, G. (2005). Categorical data analysis using the SAS System. Cary, NC: SAS Institute, Inc

باب الجغرافيا

D. Naji Kehdy D. Jocelyne Adjizian Gérard D. Georges Karam

Estimation et Variabilité de l'Evapotranspiration Potentielle dans une Zone à Stress Hydrique La Béqaa (Liban)

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ملخص:

تتطلب الإدارة المستدامة للموارد المائية وبخاصة تلك المتعلقة بالزراعة، فهماً جيداً لعناصر الميزان المائي. ويعتبر التبخ-النتح واحداً من أهم هذه العناصر: فهو يسهم في فهم الآليات التي تحكم العلاقات بين المياه السطحية والجوفية. بالإضافة إلى أنه يساهم في تقييم تذبذبات مستوى المياه في الغطاء المائي الجوفي وفي تقدير الاحتياجات المائية المطلوبة للري.

يوجد الكثير من المعادلات التي تستخدم لاحتساب مؤشر التبخر- النتح، منها التي تعتمد على درجات الحرارة (بلاناي– كريدل، هولدردج، ثرونثويث)، وأخرى على الرطوبة (أوليفيهوباباداكيس، هارغريفز) أو الطاقة (تورك). لذا قمنا بمقارنة هذه الطرق المختلفة لتحديد الطريقة الأكثر ملاءمة لمنطقة سهل البقاع، الذي يقع على تخوم المناطق القاحلة وشبه القاحلة.

استندنا في احتساب مؤشر التبخر-النتح في سهل البقاع (قضاء زحلة)، على معطيات مناخية (الحرارة والرطوبة النسبية) لمحطات كسارة ورياق وتربل، وذلك للفترة الممتدة من سنة 1998 حتى 2011.

Résumé

La gestion durable des ressources en eau et, en particulier, celles qui concernent l'agriculture, nécessite une bonne maîtrise des éléments du bilan hydrique. Un de ses éléments revêt une importance primordiale : l'Evapotranspiration Potentielle (ETP) (Amri, 2014; Lambert, 2011; Ardoin, 2000).

Ce paramètre permet de comprendre les mécanismes régissant les relations entre les eaux de surface et les eaux souterraines, d'évaluer les fluctuations du niveau piézométrique des nappes phréatiques et aussi d'estimer les besoins en eau d'irrigation (Sirrimed, 2012 in Hamimedet al., 2014).
Les formules mises au point pour calculer l'ETP sont nombreuses (Lecarpentier, 1975), elles peuvent être thermiques (Blaney–Criddle, Holdridge, Thornthwaite, ...), hygrométriques (Olivier et Papadakis, Hargreaves, …) ou énergétique (Turc). Aussi avons-nous comparé ces différentes approches afin d'identifier la méthode la plus adaptée à une zone, comme celle de la Beqaa (plaine intérieure du Liban), qui est située à la lisière des milieux arides et semi-arides.
Le calcul de l'ETP, pour la région de la Béqaa centrale (Caza du Zahlé), était basé sur une série des données climatiques (température, humidité relative) des stations météorologiques de Ksara, Rayak et Terbol, pour la période allant de 1998 à 2011.
Mots clés : Evapotranspiration potentielle, agriculture, Beqaa Centrale.

1- Introduction

L'augmentation de la population mondiale de 7 milliards d'habitants en 2011 à 9 milliards en 2050, ainsi que les incertitudes de plus en plus fortes liées notamment au changement climatique (l'augmentation anticipée des températures et la fréquence des événements extrêmes comme la sécheresse et les vagues de chaleur), pourraient provoquer une diminution des ressources en eau aux basses et moyennes latitudes, ainsi que dans les zones arides et semi-arides (World Water Forum, 2011; Gaufichonet al., 2010)

Par conséquent, il s'avère important d'optimiser l'utilisation de l'eau, notamment en agriculture, très hydrophage. Avec 70% de la consommation mondiale d'eau, l'agriculture est sans conteste le secteur d'activité le plus consommateur d'eau. Très souvent traditionnels les dispositifs d'irrigation ont un très faible rendement, et dans nos régions, ce dispositif à ciel ouvert est responsable de pertes d'eau par évaporation. Développer un système d'irrigation qui augmente la productivité de l'eau tout en l'économisant devient une priorité.

Pour accroitre l'efficacité dans l'utilisation de l'eau, il paraît important d'estimer l'évapotranspiration potentielle, notamment dans les zones arides ou semi-arides où la valeur moyenne mesurée est aux alentours de 1600 mm/an (Bouteldjaoui et al., 2011). L'ETP représente l'eau susceptible d'être perdue sous forme de vapeur par la végétation et le sol quand l'eau ne constitue pas un facteur limitant de son développement (Lebourgeois, 2010, Mjejra, 2016, Thornthwaite, 1944). Les variations de l'ETP dans le temps sont fonction des caractéristiques de la surface évaporante et du pouvoir évaporant de l'atmosphère (c'est-à-dire des caractéristiques climatiques).

Cependant, l'ETP est une donnée très difficile à obtenir dans des pays qui manquent de stations synoptiques. Aussi, elle peut être calculée à partir de formules plus ou moins complexes suivant la quantité de données climatiques disponibles. Les formules mises au point pour calculer l'ETP sont nombreuses (Le Carpentier, 1975), elles peuvent être thermiques (Blaney-Criddle, Holdridge, Thornthwaite, …), hygrométriques (Olivier et Papadakis,, Hargreaves,…) ou énergétique (Turc).

Aussi avons-nous comparé ces différentes approches afin d'identifier la méthode la plus adaptée à une zone, comme celle de la Beqaa (plaine intérieure du Liban), qui est située à la lisière des milieux arides et semi-arides.

2- Présentation de la zone d'étude

Notre zone d'étude, est située dans la plaine de la Béqaa centrale entre les deux chaines de montagnes du Mont-Liban et de l'Anti-Liban, sur une superficie d'environ 28150 hectares. Cette région est délimitée par le Caza de Baalbeck au Nord, la Syrie à l'est, les Caza de Joub Jannin et de Rachaya au Sud et le Mont-Liban à l'Ouest (Figure 1). Elle est traversée par le Litani, et comprend plusieurs aquifères contenants des sources émergentes comme Nabaa el Berdawni (Kehdy, 2013).

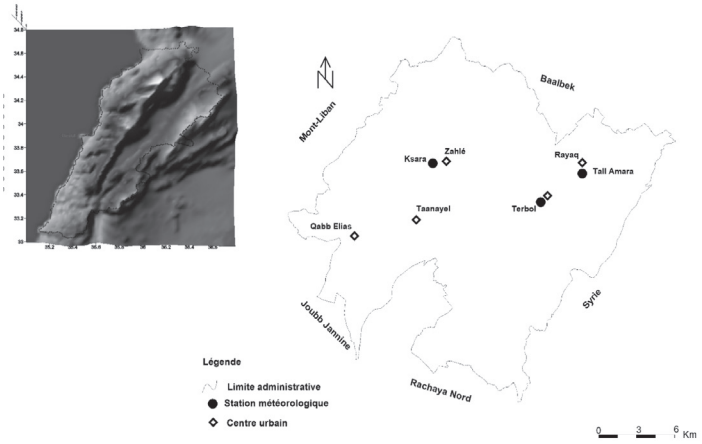

Figure 1- Localisation de la zone d'étude

Le climat est de type continental. La pluviométrie ne dépasse pas le 650 mm/an pour la période 1998-2011 (Figure 2). D'après Balaj et Raghawan (2000), les 2/3 des précipitations retournent à l'atmosphère par évapotranspiration. La température moyenne annuelle est de 14.3°C pour les stations rurales (Terbol et Rayak) et 17 ºC pour la station urbaine de Ksara. L'humidité relative moyenne annuelle est de l'ordre de 55% pour la plaine (Observatoire du Ksara, Institut des Recherches Agronomiques Tell-Amara, INCARDA Terbol).

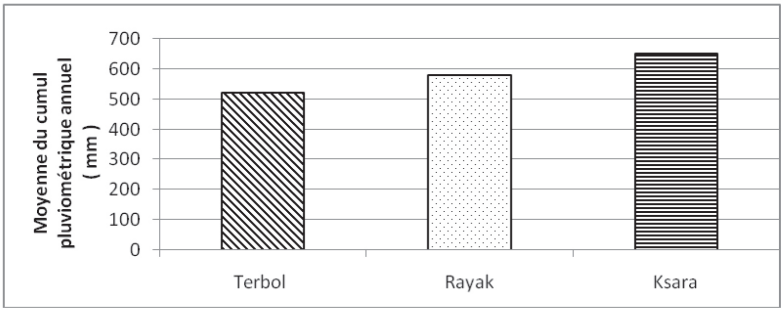

Figure 2- Moyenne du cumul pluviométrique pour 3 stations de la Béqaa Centrale (1998-2011)

La plaine de la Beqaa est essentiellement agricole. Les espèces plantées sont fortement consommatrices d'eau. L'exemple de la pomme de terre est le plus significatif. Elle constitue 65% de la production de la région. Le blé (20%) est irrigué par aspersion notamment en début de saison estivale. Le reste, comme les légumes ou la vigne (15 % de la production), ne constitue pas une menace réelle pour la ressource en eau. Les potagers sont irrigués au goutte-à-goutte et la vigne, bien qu'irriguée par des canaux, ne constitue que 4 % de l'activité agricole (Kehdy, 2013). En ce qui concerne les deux contreforts du Mont-Liban et de l'Anti-Liban, les agriculteurs ont transformé leurs versants en des terrasses plantées essentiellement de cerisiers qui ne nécessitent pas d'irrigation. Cette espèce constitue 5% de la surface agricole totale de notre région d'étude (Kehdy, 2013).

Par conséquent, le caza de Zahlé est une zone d'étude intéressante pour l'estimation de l'évapotranspiration potentielle à cause, notamment, de ses enjeux économiques et agricoles.

3- Méthodologie

Les formules mises au point pour calculer l'évapotranspiration potentielle sont nombreuses. Selon les paramètres climatiques qu'elles intègrent trois catégories apparaissent : i) les formules thermiques basées sur un seul élément climatique « la température », ii) les formules hygrométriques qui utilisent le déficit de saturation, iii) les formules énergétiques qui incluent le bilan radiatif.

Compte tenu de notre réseau météorologique insuffisant et en fonction des paramètres climatiques disponibles, nous n'avons pu traiter que les formules appartenant au deux premières catégories. Les données météorologiques de 3 stations (Ksara, Terbol et Rayak) ont un pas de temps mensuel pour la période allant de 1998 à 2011. Cette période fournit une série complète de données indispensables (température et humidité) pour le calcul de l'ETP par les formules retenues. La densité du réseau apparait faible, mais on peut considérer que ces stations sont assez représentatives du Caza. Les résultats obtenus ont pu être comparés aux données de l'ETP mesurée par la station de Talla Amara qui ne disposé que de 3 années de relevés (2009, 2010 et 2011).

3.1- Formulesthermiques

a- Blaney-Criddle (1945)

Une des plus connues et plus anciennes formule de l'ETP est celle de Blaney et Criddle (Lecarpentier, 1975)

ETP (pouces) = k t p / 100 equ.1

Dans laquelle :

t = température moyenne de la dite période en°F

p = durée d'éclairement de la période exprimée en pourcentage de la durée éclairement de l'année entière

k = coefficient variable en fonction de la région et des cultures (K = 0.7)

b- Méthode de Thornthwaite (1944)

La formule de Thornthwaite est utilisée lorsqu'on ne dispose que de la température comme seule donnée climatique. Elle exprime l'évapotranspiration potentielle (ETP) par la formule suivante :

$$Etp = 16 * \left[\frac{10*T(m)}{I}\right]^a * F(m,\varphi) \quad Etp = 16 * \left[\frac{10*T(m)}{I}\right]^a * F(m,\varphi)$$

equ 2

Dans laquelle :

ETP : Evapotranspiration moyenne du mois (m=1 à 12) en mm,

T : Moyenne interannuelle des températures du mois, oC,

a: 0.016 * I +o.5

I :Indice thermal annuel

$$I = \sum_{m=1}^{12} i(m) \quad I = \sum_{m=1}^{12} i(m)$$

$$i(m) = \left[\frac{T(m)}{5}\right]^{1.514} \qquad i(m) = \left[\frac{T(m)}{5}\right]^{1.514}$$

F(m) : Facteur correctif fonction du moi (m) et de la latitude (tableau 1)

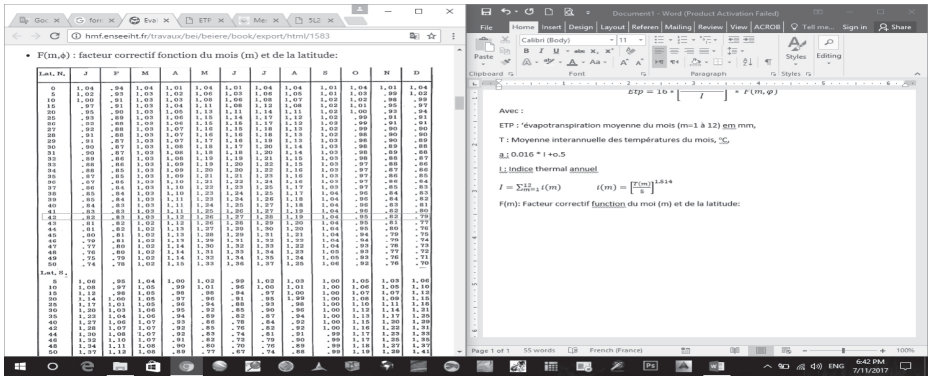

Tableau 1 : Facteur correctif fonction du moi (m) et de la latitude

c- Formule de Holdridge

Dans ce cas, l'ETP est considérée comme une fonction linéaire de la température. La formule ne nécessite pas de coefficient régional ou cultural. Cependant, le coefficient de t varie selon les mois. La formule est la suivante :

ET mm/mois = 5 t (mois de 31 jours) equ 3 a)

= 4,84 t (mois de 30 jours) equ. 3 b)

= 4,56 t (Février) equ. 3c)

Dans laquelle :

t = température moyenne en º C

3.2- Formules hygrométriques

a- formule de Papadakis

ETP = 5.625 (ea – e) equ 4

ea(mb) = tension de vapeur saturante de la température maximale moyenne (Tableau 2)

e (mb) = tension moyenne de vapeur

T (º C)	Pr. de vapeur saturante (Pa)	T (º C)	Pr. de vapeur saturante (Pa)	T (º C)	Pr. de vapeur saturante (Pa)	T (º C)	Pr. de vapeur saturante (Pa)
- 29	42.17	-9	283.93	11	1312.7	31	4495.9
- 28	46.73	-8	309.98	12	1402.6	32	4758.5
-27	51.74	-7	338.19	13	1497.8	33	5034.3
-26	57.25	-6	368.74	14	1598.75	34	5323.9
-25	63.29	-5	401.76	15	1705.5	35	5627.8
-24	69.91	-4	437.47	16	1818.4	36	5946.6
-23	77.16	-3	476.06	17	1938.0	37	6281.0
-22	85.10	-2	517.72	18	2064.3	38	6631.5
-21	93.78	-1	562.67	19	2197.8	39	6998.7
-20	103.26	0	611.15	20	2338.8	40	7383.5
-19	113.62	1	657.1	21	2487.7	41	7786.3
-18	124.92	2	706.0	22	2644.8	42	8208.0
-17	137.25	3	758.0	23	2810.4	43	8649.2
-16	150.68	4	813.5	24	2985.1	44	9110.7
-15	165.30	5	872.5	25	3169.2	45	9593.2
-14	181.22	6	935.3	26	3363.1	46	10097.6
-13	198.52	7	1002.0	27	3567.3	47	10624.6
-12	217.32	8	1072.8	28	3782.2	48	11175.1
-11	237.74	9	1148.1	29	4008.3	49	11750.0
-10	259.90	10	1228.0	30	4246.0	50	12349.9

Tableau 2: Pression de saturation (eau) en fonction de la température maximale moyenne.

4- Résultats et discussion

4.1- Choix des formules convenables pour la région d'étude

Les résultats de l'ETP calculés font apparaitre de grandes différences (fig. 3)

4.1.1- Comparaison des résultats de l'ETP

La figure 3 montre que la moyenne de l'ETP, telle que calculée par Blanney et Criddle, est de l'ordre de 1218 mm. Les écarts entre les stations sont faibles : moins de 5% (pourcentage d'erreur acceptable). Thornthwaite donne une valeur moyenne d'ETP bien plus élevée, de l'ordre de 2574 mm. Par contre les écarts entre les stations pour Thornthwaite sont plus importants, ils sont de l'ordre de 7 à 10%.

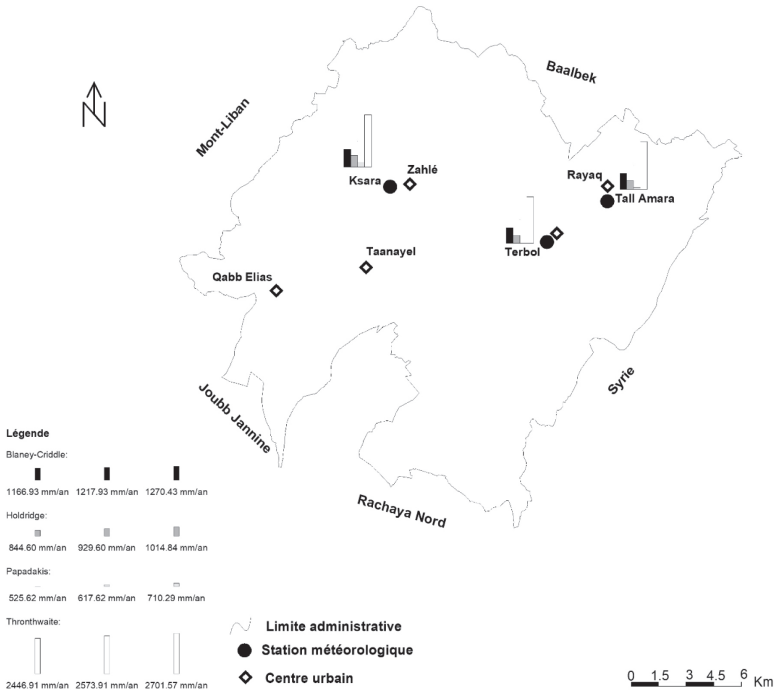

Fig. 3 : Moyenne annuelle de l'évapotranspiration potentielle estimée (en mm/an) selon 4 formules empiriques, pour la période d'étude 1998-2011.

Quant aux deux autres formules, elles donnent des valeurs moindres. On obtient 929 mm en moyenne pour Hodridge et 617 mm pour Papadakis (avec des différences significatives entres les stations). On observe une différence de plus de 76 % entre les résultats de Thornthwaite et Papadakis.

Compte tenu de ces différences dans les résultats, nous avons voulu comparé sur le seul site qui mesure l'ETP, Talla amara, les résultats calculés aux données mesurées en se basant sur les valeurs de l'écart relatif « ER » (Bouteldjaouiet al., 2011).

L'écart relatif est défini par :

ER = (ETP mesuré – ETPi) / ETP mesuré × 100 equ 5

Dans laquelle :

Année	Blaney-Criddle (mm)	Holdridge (mm)	Papadakis (mm)	Thornthwaite (mm)	ETP mesurée (mm)
2009	1164.5	844.7	822.2	2451.5	1288.5
2010	1222	947.4	637.2	2611.5	1133.3
2011	1147.1	814.8	497.1	2410.6	925.3

Tableau 3 : Valeurs annuelles de l'ETP calculées par les différentes formules dans la station de Tall El Amara (Rayak) pour les années 2009, 2010 et 2011.

Année	Blaney-Criddle	Holdridge	Papadakis	Thornthwaite
2009	1	34.4	36.2	-90.2
2010	-7	16.4	43.8	-130
2011	-23.9	11.9	46.3	-160.5

Tableau 4 : Ecart relatif des différentes méthodes d'estimation de l'ETP comparées à celle de l'ETP moyenne mesurée dans la station de Tall El Amara (Rayak) pour les années 2009, 2010 et 2011.

ETPi : ETP calculée par les méthodes empiriques utilisées.

L'analyse comparative entre les résultats annuels obtenus par les méthodes empiriques avec les valeurs mesurées de la station de Tall El Amara (Rayak) pour les années 2009 et 2010 (tableau 3 et 4) permet de mettre en évidence que l'ETP calculée par la méthode de Blaney-Criddle est celle qui est la plus proche des données mesurées (écart variant entre 1% et -7%). L'année 2011 est plus problématique puisque Holdridge est la formule qui donne les résultats théoriques ayant l'écart le plus faible (12%) avec les données relevées (tableau 4). Quelle en serait la raison ? Causes métrologiques (qualité des données, lacunes, interruption des données) ou météorologiques?

En se basant sur les années 2009-2010, il s'avère que Blaney-Criddle donne les meilleurs résultats. Cette conclusion correspond à celle de Bouteldjaoui et al., 2011, qui a travaillé sur une zone semi-aride, la région de Djelfe en Algérie. L'auteur a démontré que l'ETP calculée par la méthode de Blaney-Criddle a conduit à une bonne estimation de cette composante climatique. De plus, cette méthode a été utilisée avec succès, dans la région de Rio Negro, une des provinces méridionales de la République Argentine à contexte climatique sub-aride. Cependant, la transposition de la formule deBlaney-Criddle à d'autres climats, notamment aux climats humides, s'avère inadéquate et conduit à des résultats souvent erronés et très surestimés, au contraire de la méthode de Thornthwaite qui est valable pour ces régions (Lecarpentier, 1975).

L'analyse des ETP mensuelles (tableau 5) montre une différence selon les saisons : Holdridge donne les écarts les moins importants (de 0.9 à 14%) pour l'automne. Blaney-Criddle donne de très bons résultats pour l'été (0.1 à 9.7%) alors que pour l'hiver et le printemps les ER varient de 11.4 à 28.7%.

Mois	ETP mesurée (mm)	ETP Blaney-Criddle (mm)	ETP Holdridge (mm)	ER Blaney-Criddle	ER Holdridge
Jan	35.3	42.6	34.0	-20.7	3.7
Fév	40.6	48.8	32.5	-20.3	20.1
Mars	70.5	50.2	47.3	28.7	33.0
Avril	98.9	89.4	61.3	9.6	38.0
Mai	133.2	109.3	83.1	17.9	37.6
Juin	162.3	162.5	99.5	-0.1	38.7

Juillet	173.1	168.0	115.3	2.9	33.4
Août	140.6	154.2	118.7	-9.7	15.6
Sep	100.2	136.0	99.3	-35.7	0.9
Oct	80.5	111.9	85.9	-39.0	-6.7
Nov	46.2	66.9	52.7	-44.8	-14.0
Déc	34.1	38.0	39.6	-11.4	-16.1

Tableau 5: Ecart relatif de la moyenne mensuelle des deux méthodes d'estimation del'ETP (Blaney-Criddle et Holdridge) comparées à celle de l'ETP moyenne mesurée dans la station de Tall El Amara (Rayak) pour les années 2009, 2010 et 2011.

4.1.2- Evolution temporelle

Une approche comparative de l'évolution temporelle des moyennes de l'ETP, tels que calculées par Blanney-Criddle (Figure 4) pour la période retenue et sur les 3 stations montre une bonne correspondance des résultats pour la période automnale et hivernale. On relève un léger décrochement pour ksara en été. L'ETP y est bien plus élevée qu'ailleurs.

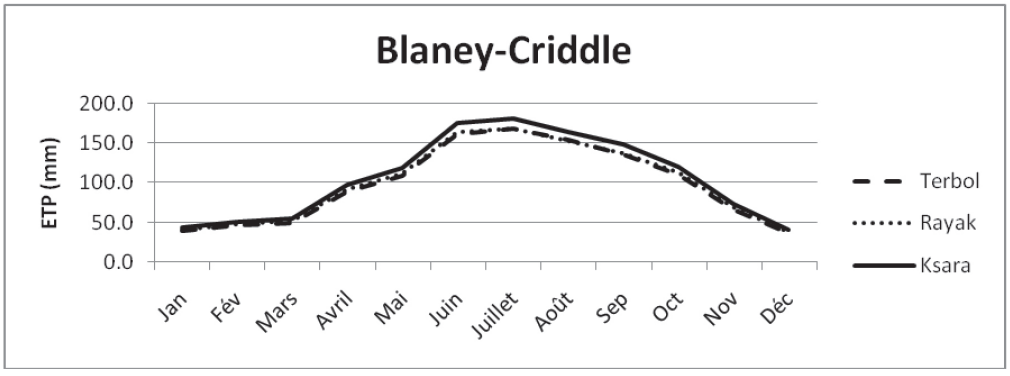

Figure 4 : Moyenne mensuelle de l'ETP estimée par la méthode de Blaney-Criddle pour la période 1998-2011.

Cette augmentation estivale revient à la présence de la sécheresse pendant les mois de l'été, où les précipitations sont quasi absentes, avec une élévation de la température, augmentation de la radiation solaire et de la quantité de l'évaporation accompagné avec une diminution de l'humidité. L'écart entre le maximum estivale et le minimum (fig. 5) hivernale et plus de 350 mm selon Blaney-Criddle et plus de 230 selon Holdridge, cette situation oblige les agriculteurs à augmenter leurs heures d'irrigation en augmentant le débit de prélèvement des puits, en créant ainsi une pression accrue sur les ressources en eau souterraines.

Avec Hodridge, si les courbes de Rayak et Terbol sont bien confondues (Figure 5), On remarque que Ksara donne des résultats supérieurs, notamment en été, aux deux autres stations. Si les courbes de Rayak et Terbol sont confondues chgezHoldridge, on consate qu'à Ksara les valeurs restent plus

élevées, notamment durant la période printanière et estivale.

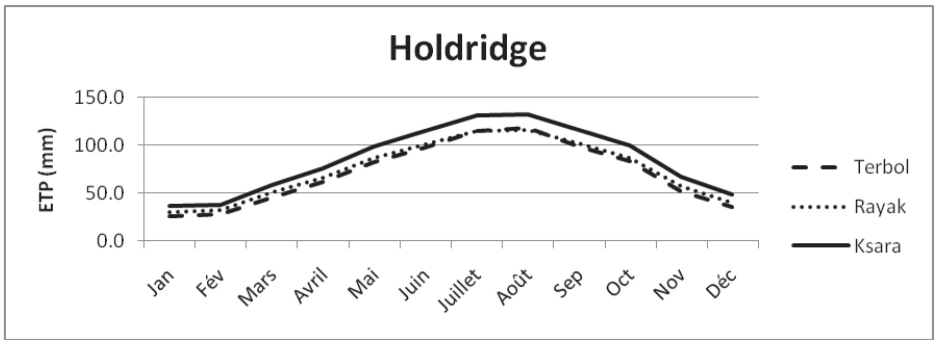

Figure 5 : Moyenne mensuelle de l'ETP estimée par la méthode de Holdridge, pour la période 1998-2011.

Cet écart entre la station urbaine (Ksara) et les deux autres, plus rurales (Terbol et Rayak) pourrait s'expliquer par le paramètre température des deux formules de l'ETP, notamment chez Holdridge. Ce paramètre climatique est remarquablement plus élevé dans la station du Ksara à cause de sa nature urbaine (îlot de chaleur urbain) et à cause de sa position géographique sur les versants Est du Mont-Liban où elle subirait l'effet de foehn qui engendre un réchauffement intense.

5- Conclusion

L'évapotranspiration potentielle, qui traduit la "demande en eau" du climat, a été estimée par différentes méthodes en se basant sur les variables climatiques relevées au niveau des stations météorologiques de Terbol, Tal El Amara (Rayak) et Ksara durant la période 1998-2011.

L'analyse comparative des résultats obtenus permet de mettre en évidence :

A l'échelle annuelle, la formule de Blaney-Criddle semble estimer le mieux l'évapotranspiration potentielle dans les régions semi-arides comme celles de la Beqaa, avec peu d'écarts dans les résultats entre les stations. La formule de Thornthwaite semble fortement surestimée l'ETP alors que celle de Papadakis la sous-estime considérablement.

A l'échelle mensuelle, l'estimation de l'ETP est plus problématique. La méthode de Blaney-Criddle conduit à une meilleure approximation de cette composante pour les deux périodes printanière et estivale, tandis que la méthode de Holdridge serait plus adaptée pour la période automnale.

L'évolution mensuelle calculée de l'ETP mensuelle basée sur le critère thermique montre une différence selon les caractéristiques géographiques de la station. Les deux stations rurales (Terbol et Rayak) semblent avoir le même comportement alors que le site urbain connaitrait une ETP bien plus élevée.

Cette première approche montre la difficulté d'estimer l'ETP en l'absence de stations de mesures d'une part et, d'autre part, l'importance des caractéristiques géographiques des sites. Ainsi, compte tenu de l'importance de l'ETP, notamment dans une région comme la Beqaa, il s'agira de l'appréhender dans sa dimension spatiale afin de pouvoir mettre en relation l'occupation du sol, l'ETP et l'évapotranspiration réelle (ETR).

6- Références bibliographiques

1-Amri R, 2014 : Estimation régionale de l'évapotranspiration sur la plaine de Kairouane (Tunisie) à partir de données satellites multi-capteurs. Hal, archives-ouvertes, 176p.

2-Ardoin S., 2000 : Prise en compte des spécificites de l'évapotranspiration en zone semi-aride dans la modélisation globale de la relation pluie-débit. Mémoire de DEA, sciences de l'eau dans l'environnement continental, 114p.

3-Bouteldjaoui F, Bessenasse M, Guendouz A., 2011 : Etude comparative des différentes méthodes d'estimation de l'évapotranspiration en zone semi-aride (cas de la région de Djelfa). Nature et technologie, pp109-116.

4-Gaufichon, L., Prioul, J.L., Bachelier, B., 2010. Quelles sont les perspectives d'amélioration génétique deplantes cultivées tolérantes à la sécheresse ? Fondation FARM.

5-Hamimed A, Nehal L, Khaldi A, Azzaz H., 2014 : Contribution à la spatialisation de l'évapotranspiration d'un agro-système semi-aride en Algérie par utilisation de la télédétection et du modèle METRIC, Physio-Géo, volume 8, 58p.

6-Kehdy N., 2013 : la gestion intégrée quantitative de la ressource en eau souterraine, cas du Kaza de Zahlé. Thèse présentée en vue de l'obtention du doctorat, Université Saint-Joseph, Beyrouth, 330p.

7-Lambert S, 2011 : Impacts des changements climatiques sur la disponibilité de l'eau dans le sud de Québec. Essai présenté au Centre Universitaire de Formation en Environnement en vue de l'obtention du grade de maître en environnement, 58p.

8-Le Bourgeois F., 2010: Cours de bioclimatologie à l'usage des forestiers, institut des sciences et industries du vivant et de l'environnement, 245p.

9-Lecarpentier C., 1975 : l'évapotranspiration potentielle et ses implications géographiques. Annales de géographie, pp. 385- 414.

10- Mjejra M., 2016 : Etude de l'évapotranspiration dans le bassin versant de Mjerda (en Tunisie) : apport de la télédétection satellitaire et des systèmes d'information géographiques. Hal, archives-ouvertes, 300p.

11- Thornthwaite, C. W., 1944. Report of the committee on transpiration and evaporation. Trans. Am. Geophys. Union, 5: 687 pp.

12- World Water Forum, 2011.Background Note for the Thematic Priority "Contribute to Food Security by Optimal Use of Water" of the World Water Forum 6. Draft May 2011. Thematic Process Core Group.