

STRATEGIES FOR COPING WITH WEATHER CHANGES ADOPTED BY AGRICULTURE TEACHERS AND STUDENTS OF SHISELWENI REGION HIGH SCHOOLS, SWAZILAND

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SUMMARY

Prolonged weather changes often have deleterious effects on crops, animals and soils. An investigation was conducted to determine the coping strategies adopted by students and teachers of High Schools in Shiselweni Region of Swaziland, to mitigate or eliminate the adverse effects of weather changes. The study tested the hypothesis that there was no significant difference in gender of students, school residential status, science subject combination taken, people with whom students lived, location of school, and observed weather changes, coping strategies for weather changes, and effectiveness of weather information dissemination measures. A validated questionnaire with a reliability coefficient of 0.73 and 0.88 as given by students and staff respectively, was used to collect data from 115 students and 28 teachers of agriculture in 12 schools. Systematic sampling technique with a random start was used to select students from the list of those who were taking agriculture, while all the agriculture teachers in the schools were studied. Findings show that the weather changes which posed important problems included changes in temperature, which resulted in increasing hot days in summer, and more and high heat waves, changes in temperature, and changes in rainfall duration. Important problems which resulted from the weather changes included changes in soil properties, increasing deforestation, changes in location of range and agricultural pests, and high risk of famine, prolonged droughts, increasing deforestation, respiratory diseases, changes in location of range and agricultural pests. Important strategies for coping with weather changes include: proper planning of time table, use of air-conditioners, different styles of teaching, strict rule on wearing of school uniforms, provision of green houses. Some effective information dissemination measures on weather changes included improving accessibility of climate information, and support from established environmental bodies. The ANOVA F- values obtained by using students data showed that urban schools disseminated information on weather changes more than semi-urban and rural schools ($F = 3.21$, $P = 0.04$). Students who took combined sciences mentioned important strategies in coping with weather changes more than those who took other science subjects ($F = 3.33$, $P = 0.40$). Similarly, students who lived with fathers identified more strategies than those who lived with the two parents, mothers, relatives, friends, guardians, or alone ($F = 3.33$, $P = 0.04$). In conclusion, respondents identified few weather changes, and coping strategies. Few means of disseminating information on weather changes and coping strategies were effective. It is recommended that education on weather changes, coping strategies, and information dissemination measures on weather changes be intensified in schools and community extension service.

1. INTRODUCTION

1.1 Weather

This is a set of all the phenomena, especially rainfall and temperature, occurring in a given atmosphere at a given time. Whereas, **climate** is the average atmospheric condition over longer periods of time. Over thousands of years, changes in earth's orbit affect the amount and distribution of solar energy received by the earth, and influence long-term climate. Agricultural Education and Agricultural Extension professionals are therefore interested not only in the long run changes in climate, but particularly in the short run weather changes which influence farmers, crops and livestock, and are consequences of climate change. Weather phenomena on earth include temperature, pressure, relative humidity, wind, cloud, rain, snow, fog, dust

storm, natural disasters, such as tornadoes, hurricanes, typhoons and ice storms; they occur mainly in the **troposphere**, which is the lower part of the atmosphere (Wikipedia, 2010).

1.2 Climate Change

This is the change in the statistical distribution of weather over periods of time that range from decades to millions of years. It is a change in average weather of a region or the whole earth. It may be regarded as anthropogenic or human-causing climate change known as anthropogenic **global warming**. The factors which shape climate include variations in solar radiation, deviations in the earth's orbit, mountain building and continental drift, and changes in green house gas concentration. Anthropogenic factors are human activities which change the environment, such as irrigation, increase in carbon dioxide emissions from fossil fuel combustion, ozone depletion, animal agriculture and deforestation, which also influence climate change (Wikipedia, 2010).

1.3 Global Warming

This is the increase in the average temperature of the earth's near-surface air and oceans since the mid-twentieth century and its projected continuation. It is caused largely by increasing concentration of greenhouse gases resulting from human activities such as fossil fuel burning, and deforestation. Greenhouse effect is the process by which absorption and emission of infrared radiation by gases in the atmosphere warm a planet's lower atmosphere and surface. The major greenhouse gases are water vapour, carbon dioxide, methane, and ozone. Global warming is measured by the globally averaged temperature near the earth's surface. It increased by $0.74^{\circ}\text{C} \pm 0.18^{\circ}\text{C}$ over the period 1906 – 2005 (Wikipedia, 2010).

1.4 Effects of Weather and Climate Changes on Agriculture

Weather and climate changes influence agriculture through changes in temperature, water content of the air and soil, and its availability. Different crop species react differently to increased Carbon Dioxide concentrations, changes in temperature, precipitation, pollutants, ultra-violet radiation. For instance, free-air Carbon Dioxide enrichment experiment (FACE) in Arizona, USA, showed that cotton was highly responsive to elevated Carbon Dioxide, whereas, wheat was much less responsive (Allen, 1993). Excessively high temperature limits soil binding properties and chemical release and movement within the soil (Furuya and Kataoka, 1993). Excessively high temperature results in heat stress to the farmer, plants and animals, which may lead to lower milk yield, soil baking, plant wilting and death. Excessive water also leads to water-logging of soils, flooding which results in destruction of farm buildings, plants and animals. Strong wind causes erosion, lodging of plants, and disruption of electricity supply on the farm.

1.5 Strategies for Combating the Effects of Weather and Climate Changes

These include *mitigation* of global warming which involves reduction in the rate of anthropogenic greenhouse gas release. The Kyoto Protocol on this, which has been signed by over 160 countries, except the United States, expires in 2012. In December 2009 the United Nations Climate Change Conference met in Copenhagen, but made no binding agreement on climate change mitigation. *Adaptation* strategies include installation of air-conditioning equipment, abandoning settlements threatened by sea levels, water rationing, water conservation, adaptive agricultural practices, construction of flood defences, changes to medical care, and interventions to protect threatened species. *Geo-engineering* is the concept of planetary engineering applied to earth. It is the deliberate modification of Earth's natural environment on a large scale to suit human need. An example is greenhouse gas remediation, which involves removal of greenhouse gases from the atmosphere, usually through carbon sequestration techniques such as carbon dioxide air capture. (Wikipedia, 2010).

1.6 Strategies for Environmental Education in Swaziland

The Swaziland Environmental Authority (1997), in its Action Plan, included four interlinked programmes: First, School and Colleges Programme facilitates integration of Environmental Education into the curricula, the in-service and pre-service training of teachers; development of

teaching and learning resources, and strengthening of human capacity to deliver environmental education. Second, Community Programme, to strengthen local communities to understand, and participate in the sustainable management of their environment. Third, public awareness, Research, Information, and Technical messages: The aim is to raise level of environmental awareness, motivate the public to adopt environmentally sustainable habits, make environmental information accessible, encourage research in environmental education, and develop technically correct environmental messages. Fourth, Environmental Education and Resource Centre Programme, which provides visitors and communities with environmental resource materials, and conducts visits to schools, and outreach programmes to the communities.

The National Environmental Education Programme carries out, or intends to carry out the following activities: Commemorative Day Celebrations such as World Environment Day, World Meteorological Day, in which the general public are mobilized and informed on environmental issues. Environmental Nature Conservation Radio Programme, in which environmental education is provided on radio. Academic Services in which the University of Swaziland is supported in carrying out environmental research on biodiversity. Rural Community Training on environmental conservation. Many of the measures had been scarcely realized (Swaziland National Trust Commission, 2010).

1.7 Environmental Information Dissemination Measures

Radio programmes, newsletters and Agricultural Extension Agents could serve as avenues for teaching rural communities environmental protection messages. Hence inclusion of the subject in the curricula of training institutions such as High Schools, industrial research and training institutions, universities, agricultural and forestry colleges, and vocational institutions, becomes essential.

1.8 Objectives and Hypothesis of the Study

To determine the weather changes, coping strategies, and effectiveness of information strategies on weather changes adopted by respondents. It was **hypothesized** that there was no significant difference in the demographic characteristics of students, school location; and observed weather changes, coping strategies, and effectiveness of information dissemination measures.

2. METHODOLOGY

2.1 Target Population, Instrumentation, Validity and Reliability

The target population for the study consists of students and teachers of agriculture in Shiselweni Region High Schools. The questionnaire for data collection used the Likert scale type of questions with 1 – 6 possible responses to each question, such as strongly agree to each item which scored 6; agree, 4; slightly agree, 3; slightly disagree, 3; disagree, 2; strongly disagree, 1. Content validity of the instrument was determined through the use of three High School teachers and three students who did not teach or take Agricultural Science as judges. The reliability coefficients, r of 0.73 and 0.88 of the questionnaire were determined from students' and teachers' responses, respectively, using the test-retest technique at an interval of two weeks.

2.2 Sample Selection, Data Collection, and Data Analysis

Data collection took place from all the 28 agriculture teachers in the 12 High Schools chosen out of 27 which offer agriculture in Shiselweni Region. Nine to 10 agriculture students were selected from the list of agriculture students in each school, using systematic sampling with a random start, to make a total of 115 students included in the study. There are 47 High Schools in the region (Regional Education Office, 2009). The questionnaire was given to the respondents for completion, and all the copies were completed. Frequencies, percentages, means and standard deviations were used to describe the findings. Analysis of Variance was used to test the hypothesis.

3. RESULTS AND DISCUSSION

3.1 Observed Weather/Climate/Environmental Changes

Data in Table 1 indicate that students (M = 4.71, SD = 0.86) and teachers (M = 4.04, SD = 0.90) were aware of weather/climate/environmental changes in their schools and communities. The changes observed by students included changes in temperature, increasing hot days in summer, evidence of more and high heat waves. Observed changes by teachers included changes in temperature, rainfall duration, and increasing hot days in summer. The effects of the changes commonly noticed by students and teachers included increasing deforestation, high risk of famine, and changes in location of range agricultural pests. The effects noticed by students only included changes in soil properties, and increased desertification. The effects noticed by teachers only were: more extensive and prolonged droughts, and greater frequency of asthma and respiratory diseases. It could be seen that weather and climate changes were having undesirable effects on the people, farm animals and soils. This is consistent with the report in Wikipedia (2010) that the human body is negatively affected by extremes in temperature, humidity and wind.

Table 1: Awareness of environmental changes, weather changes observed, and effects of weather changes as constituting problems.

	Awareness, changes and effects	Students M	Students SD	Teachers M	Teachers SD
1.	Awareness: Aware of environmental/weather/climate changes in schools and community	4.17	0.86	4.04	0.90
2.	Observed changes: Temperature	3.75	0.88	3.58	1.02
3.	Distinguish between different seasons	3.14	0.89	2.72	0.86
4.	Changes in rainfall duration	2.71	1.15	4.23	0.92
5.	Increasingly hot days in summer	3.85	0.97	4.32	0.98
6.	More and high heat waves	4.00	1.12	2.59	0.67
7.	Effects: Heat illness and death	2.46	0.79	2.63	0.63
8.	More extensive and prolonged drought	2.67	0.72	4.53	0.93
9.	Changes in soil properties	4.32	1.02	3.18	0.88
10.	Evidence of increasing deforestation	3.71	0.81	4.33	0.84
11.	Evidence of increasing desertification	4.03	1.03	2.80	0.79
12.	Increase in diseases such as malaria	3.10	0.95	2.68	0.58
13.	Greater frequency of asthma and other respiratory diseases	2.71	0.59	3.64	0.66
14.	High risk of famine	3.67	0.77	4.15	0.79
15.	Changes in location of range agricultural pests	4.35	0.82	4.22	0.88
	Overall	3.51	0.90	3.58	0.82

M = Mean, SD = Standard Deviation; M ≥ 3.5 = Constitutes a problem; M < 3.5 = Does not constitute a problem.

3.2 Importance of Strategies Used in Coping With Effects of Weather Changes

Data in Table 2 show that both students and teachers commonly regarded many strategies employed as important. These strategies included proper planning of time table by allowing flexibility, use of air conditioners, employing varying styles of teaching, introducing strict rules in wearing of uniforms, provision of green houses. Others include collection, analysis, and use of meteorological data, proper use of teaching aids, provision of food for the students, and availability of water around school premises. The only strategy identified by students only as important is construction of dams, waterways, and terraces. Other strategies that might ordinarily be considered as apparently important such as use of advanced technology like computer, wearing protective clothing, use of improved cultivars, and early closing of schools, were only slightly unimportant (Grand Mean = 3.1). It was surprising that use of improved cultivars fell into this category because drought resistant maize has been available for cultivation in Swaziland.

Table 2: Importance of the strategies for coping with weather changes in schools.

Importance of coping strategies	Teachers		Students	
	M	SD	M	SD
1. Proper planning of time table (flexibility)	3.89	0.83	3.93	1.01
2. Use of advanced technology like computer	3.07	0.85	2.93	0.85
3. Use of air-conditioners	3.92	0.71	3.99	0.80
4. Varying styles of teaching	4.35	0.73	4.40	0.74
5. Strict rules on wearing of uniforms	3.53	1.34	4.29	1.17
6. Emphasis on wearing protective clothing	3.14	0.89	2.92	0.94
7. Provision of Greenhouses	4.17	1.12	4.60	0.94
8. The use of improved cultivars	3.25	0.84	3.29	2.91
9. Collection, analysis and use of meteorological data	4.07	0.94	4.29	0.90
10. Dismissal of students because of bad weather	3.14	0.89	3.13	1.19
11. Construction of dams, water-ways, and terraces	3.21	0.78	3.84	0.95
12. Early closing of schools for the term	3.07	0.81	3.21	0.92
13. Proper use of teaching aids	4.14	1.20	4.13	1.01
14. Provision of food for the students	4.21	1.13	4.20	1.08
15. Availability of water around school premises	3.96	0.99	4.27	0.93
16. Proper functioning of health facilities	3.14	0.84	3.15	1.18
Overall	3.64	0.93	3.78	1.09

Mean $M \geq 3.5$ = Important; $M < 3.5$ = Not important; SD = Standard Deviation

3.3 Effectiveness of Information Dissemination Measures

Both teachers and students regarded improving accessibility to information, and encouraging research skills on the measures were the effective measures. The teachers only, identified as effective, integrating measures into school curricula, support from Global Climate Centres, improving accessibility to information, encouraging research skills on the measures, and conducting an outreach to communities ($M = 4.14$, $SD = 1.20$). The students only, identified as effective, training students through group discussion, involvement of communities in learning strategies, and support from established environmental clubs. It is noteworthy that the teachers identified conducting community outreach as effective, in spite of their engagements in schools (Table 3).

Table 3: Effectiveness of measures used for information dissemination on weather changes.

Measures	Teacher	Teacher	Student	Student
	M	SD	M	SD
1. Integrating strategies in school curricula	4.21	0.95	3.15	1.16
2. Training students through group discussion	3.25	0.88	4.35	0.90
3. Training teachers through in-service training	3.21	0.91	3.18	1.20
4. Involvement of communities in learning strategies	2.85	0.75	3.86	0.99
5. Support from Global Climate Centres	4.14	1.20	3.15	0.90
6. Improving accessibility to information	4.21	1.13	4.13	1.01
7. Encouraging research skills on the strategies	3.96	0.99	4.20	1.08
8. Support from established environmental clubs	3.14	0.84	4.27	0.93
9. Conducting an outreach to communities	4.14	1.20	3.15	1.18
Overall	3.68	0.99	3.71	1.04

Mean $M \geq 3.50$ = Effective; Mean $M < 3.50$ = Not Effective; SD = Standard Deviation

3.4 Testing of Hypothesis

3.4.1 Gender

Data in Table 4 show no significant difference between males and females in observed weather changes ($F = 0.15$, $P = 0.70$), strategies for coping with weather changes ($F = 2.24$, $P = 0.14$) and effectiveness of measures for coping with information dissemination on weather changes ($F = 0.28$, $P = 0.60$). This means that both males and females similarly perceived the weather changes, weather coping strategies, and information dissemination measures.

3.4.2 Residential Status

There was no significant difference between borders and day students in observed weather changes ($F = 2.76$, $P = 0.10$), strategies for coping with weather changes ($F = 0.95$, $P = 0.33$), and effectiveness of measures for information dissemination ($F = 0.84$, $P = 0.36$) (Table 4). This means that both borders and day students had similar observations on these dimensions.

3.4.3 Science Subject Combinations Taken

Data in Table 4 show that students who took combined sciences scored significantly higher ($M = 58.1$, $F = 3.33$, $P = 0.04$) than those who took physics, chemistry and biology ($M = 52.9$), on the perceived important of the strategies adopted by agriculture teachers and students.

Table 4: Results of testing the hypothesis on the difference in demographic characteristics of students, school location and other dependent variables.

Characteristics	Observed weather changes				Strategies for coping with weather changes				Effectiveness of weather inform. dissemin. measures			
	N	M	F	P	N	M	F	P	N	M	F	P
Gender: Male	64	50.1	0.15	0.70	64	57.4	2.24	0.14	64	30.2	0.28	0.60
Female	51	49.4			51	57.9			51	31.4		
Residential status:												
Boarder	15	51.6	2.77	0.09	15	59.0	0.96	0.33	15	31.7	0.84	0.36
Day student	100	49.6			100	57.4			100	30.6		
Science subject:												
Physics, Chem. Biol	9	48.1	0.85	0.43	9	52.9	3.33	0.04	9	28.1	2.27	0.11
Physics, Chemistry	55	50.1			55	57.9			55	30.7		
Combined sciences	51	49.8			51	58.1			51	31.3		
People lived with:												
Both Parents	30	48.1	.65	0.43	30	56.6	3.33	0.04	30	31.2	2.27	0.11
Mother	34	50.8			34	59.2			34	31.11		
Father	5	50.4			5	60.5			5	33.3		
Relatives	27	50.7			27	57.6			27	30.3		
Friends	5	50.3			5	55.5			5	27.8		
Alone	4	49.3			4	55.8			4	28.9		
Guardians	10	48.3			10	55.6			10	30.4		
School location												
Urban	41	49.9	0.10	0.90	41	35.7	0.26	0.77	41	31.9	3.21	0.05
Rural	50	49.9			50	57.6			50	29.7		
Semi-urban	24	49.4			24	56.9			24	30.9		

N = Number of respondents in a category, M = Mean, F = Fisher's statistic, P = Level of significance

3.4.4 Persons with Whom Students Lived

Information in Table 4 show that students who lived with their fathers scored significantly higher ($M = 60.5$, $F = 3.33$, $P = 0.04$) than those who lived with friends ($M = 55.5$), guardians ($M = 55.6$), both parents ($M = 56.6$), relatives ($M = 57.6$) and mothers ($M = 59.2$). It could be observed that the means for the fathers and mothers were close. It appears that students who

were biologically close to those with whom they lived scored higher on perceived importance of strategies for information dissemination on weather changes, than those who were not.

3.4.5 School Location

Respondents from urban schools scored significantly higher in effectiveness of information dissemination measures ($M = 31.9$, $F = 3.21$, $P = 0.04$) than those from semi-urban ($M = 30.9$) or rural ($M = 29.7$) schools. These findings mean that urban schools utilized various strategies in coping with weather changes more than semi-urban or rural schools (Table 4).

4. CONCLUSIONS AND RECOMMENDATIONS

The weather changes observed by the respondents which constituted problems to them included changes in temperature, changes in rainfall duration, increasingly hot days in summer, and evidence of more and high heat waves. The effects of the changes in weather included more extensive and prolonged droughts, changes in soil properties, evidence of increasing desertification, evidence of increasing deforestation, greater frequencies of asthma and other respiratory diseases, high risk of famine, changes in location of range agricultural pests. The important strategies employed by the schools for coping with effects of changes in weather included proper planning of time tables to allow flexibility, use of air-conditioners, varying styles of teaching, strict rules on wearing of school uniforms, provision of greenhouses, collection, analysis and use of meteorological data, proper use of teaching aids, provision of food for the students, and availability of water around school premises. The effective measures for disseminating information on weather changes included increasing accessibility of weather information such as distributing information resources in libraries, encouraging research skills on the measures, and support from established environmental clubs. Students from urban schools scored higher in information dissemination measures on weather changes than those from semi-urban or rural schools. Students who took combined sciences scored higher in strategies for coping with weather changes than those who took physics and chemistry; or physics, chemistry, biology. Students who lived with their fathers scored higher in coping strategies for weather changes than those who lived with fathers and mothers, mothers, relatives, friends, guardians, or lived alone.

5. RECOMMENDATIONS AND EXTENSION IMPLICATION

Desertification should be arrested through aggressive tree planting programmes, enactment and enforcement of laws on tree felling for firewood. Bush-burning has to be curbed through stronger measures and tough penalties, as well as education. This recommendation becomes pertinent because hot and dry weather with wind spread fire over vast areas of land. **Extension implication:** The strategies for coping with weather changes in the communities have to involve Extension Agents who are expected to be in constant contact with farmers. Hence, training of extension staff should include concepts and skill development in management of changes in climate and weather. Effective extension for supplying irrigation water, and providing drainage facilities in water-logged areas, is a *sine qua non* for farmers to plant their crops at the right time. Digging of bore-holes, deep wells, water capture and storage during rainy seasons, are options for accessing water during periods of shortage. Measures for disseminating information on climate and weather changes should include more radio and television programmes, display of posters in public places, inclusion of environmental information in training curricula at all levels in public, private and technical training institutions.

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