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Preservice Teachers' Knowledge of Deltas and Delta Dynamics

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Abstract

There are many and often interrelated reasons for the dramatic loss of wetlands and coastal erosion in the Mississippi River Delta area including human activity and natural causes. It seems that a fundamental understanding of how these fragile lands are formed through a process of delta building, delta switching, and decay known as the delta cycle (Coleman, Roberts, and Stone, 1998) will help in understanding how the deterioration of the US Gulf coast and wetlands is occurring. Understanding of the geology of delta building and deterioration is essential to ongoing plans dealing with coastal wetland loss along the Gulf Coast. A survey instrument was developed and administered to 100 preservice teachers at a regional university in Louisiana. Students were a mix of elementary and secondary areas of certification. The students were enrolled in a methods course that is taken right before student teaching. The questionnaire focused on student knowledge of deltas in general and globally with specific questions focusing on the delta formation, switch and decay model of the Mississippi River. Important results include that there is a lack of understanding why a river will over time shift course and form a new delta, and a lack of conceptual understanding of Mississippi River dynamics and root causes of coastal erosion. It is suggested that curriculum planners and instructors of teacher education programs make sure that their candidates are presented with opportunities to enhance their understanding of concepts related to coastal erosion and wetland loss.

Key words: Delta, Delta Dynamics, Coastal Erosion, Preservice teachers, subsidence

1. Introduction

Popular press, classroom teachers, civic organizations, and political discourse put coastal erosion and wetland loss forward as a hot button issue.

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This wide spread attention has been accelerated by major events such as Hurricane Katrina, the BP oil spill, and opening of flood protection spillways. There is general recognition that the geological landscape is changing at a visible and dramatic rate in coastal Louisiana. Land loss rates in the 1970's were calculated to be 44 square miles per year. Since then the rate of wetland loss has slowed, but continues at a rate of 24 square miles per year (Barras, J.A., P.E. Bourgeois, & L.R. Handley. 1994). That is equivalent to a land area the size of a football field being lost every 38 minutes. This accounts for 90% of the coastal marsh loss in the lower 48 states. These coastal wetlands sustain commercial and recreational fisheries, agricultural interests, waterfowl habitat, and storm surge protection. The value of these coastal wetlands to the US economy is measured in the billions of dollars (Louisiana Dept. of Natural Resources). Further, storm events dramatically demonstrate the vulnerable position of urban and suburban populations centers as well as industrial interests to coastal and storm flooding attributable to wetland loss and coastal erosion. Such wetlands and marshes for the most part, act as buffers that stand between storm surges and cities like New Orleans thus absorbing the surge of a major hurricane. It is calculated that every 2.7 miles of wetland absorbs one foot of storm surge (USACOE, 1963).

There are many and often interrelated reasons for the dramatic loss of wetlands and coastal erosion in this area including human activity natural and causes. It seems that a fundamental understanding of how these fragile lands are formed through a process of delta building, delta switching, and decay known as the delta cycle (Coleman, Roberts, and Stone, 1998) will help in understanding how the deterioration of the coast and wetlands is occurring. Understanding of the geology of delta building and deterioration is essential to ongoing plans dealing with coastal wetland loss in Louisiana. It is essential for school children to learn and for decision makers to understand their own backyard or regional geology as billion dollar projects are directed at the problem (Trowbridge, 2009).World-wide close to half a billion people live on or near deltas often in large cities (Syvitski, et al., 2009). Therefore, an understanding of delta dynamics is also a global issue.

The realization that American students should be informed citizens, able to critically evaluate environmental issues and others related to science has been an aim of scientists, mathematicians, engineers and educators for many years.

In response, the goals initially stated in the 1989 report *Science for All Americans* published by Project 2061, the Benchmarks for Scientific Literacy (1993), were established to revise the K-12 science curriculum. Both Project 2061 and the National Science Education Standards (NSES) released in 1996 share common objectives in that each group purports the idea that science literacy is essential in today's society. Project 2061 and NSES deem that access to science knowledge, skills, and processes in combination engenders science literacy. Being able to understand and discuss critical issues, including those that affect the environment are as important as developing pedagogy that utilizes hands-on activities (NRC, 1996).

The Standards recognize two important reasons for becoming scientifically literate. The first is the sheer excitement and personal fulfillment of understanding science concepts. The second is to exercise decision making abilities on science-related issues, including Louisiana's coastal erosion and wetland loss. NSES stated: "…the collective judgment of our people will determine how we manage shared resources—such as air, water, and national forests" (NRC, 1996, p.11). Unsurprisingly, Louisiana students are directly affected by, and will affect, the future of the coast and wetlands that support the natural resources of the state. An example of current federal legislation being considered by Congress which directly impacts Louisiana is The Resources and Ecosystems Sustainability, Tourist Opportunity, and Revived Economies of the Gulf States Act of 2011 or the Restore Act. This legislation is intended to hold the parties who caused the Gulf oil spill accountable in restoring the Gulf by investing fines owed by British Petroleum and any other responsible parties back into the Gulf region.

NSES also recognizes that today's workplace relegates high importance to creative problem solving, which logically necessitates acquiring science knowledge and using the scientific process. To compete in the global market, American citizens must be on an equal playing field with regards to science literacy (NRC, 1996).

NSES's Standard E *Science and Technology* and Standard F *Science in Personal and Social Perspectives for Earth and Space* pointedly stress the need to educate students so that they may act on personal and social issues. NSES states that the concepts recommended to be included in the curriculum "afford students a foundation on which to base decisions they will face as citizens" (NRC, 1996, p. 107). These content standards specifically include the importance of understanding the relationship of science and technology and attaining knowledge of resources, the environment and natural hazards (NRC, 1996, pp. 109-111).

To meet the needs of 21st Century students, the NRC developed The *Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas released in July, 2011*. It includes in the Earth and Space Sciences Core Idea 3, the topics of natural resources, natural hazards, human impacts on Earth's systems and global climate change. The new framework calls for all 12th graders to have sufficient knowledge of science and engineering "to engage in public discussions on science-related issues, to be critical consumers of scientific information related to their everyday lives, and to continue to learn about science throughout their lives" (NRC, 2012, p. 9).

Considering the importance of a conceptual understanding of delta dynamics it is worth considering what future teachers may know about this process and deltas in general; thus, asking what concepts do preservice teachers have about delta dynamics?

2. Methods

A survey instrument was developed and administered to 100 preservice teachers at a regional university in Louisiana. Students were a mix of elementary and secondary areas of certification. The students were enrolled in a methods course that is taken right before student teaching. All students have had one earth science course as part of their curriculum. Many of the questionnaire items are frequent topics in the media such as subsidence and sediment supply. The questionnaire consisted of nine questions of mixed format response including true & false, listing, and open ended response that focused on student knowledge of deltas in general and globally with specific questions focusing the delta formation, switch and decay model of the Mississippi River. The questions were prioritized and selected from a pool of 20 possible questions. We wanted to keep a reasonable timeframe for responses of 15 minutes. A university geologist and supporting marine educator were asked to examine the questions for content validity. It is a major assumption of the authors that the Mississippi River Delta dynamics explain many of the coastal erosion issues facing Louisiana.

The authors were the instructors that administered the questionnaire to their classes. All permissions were obtained including IRB approval. All students were volunteers with signed permission forms and allowed to opt out at any time.

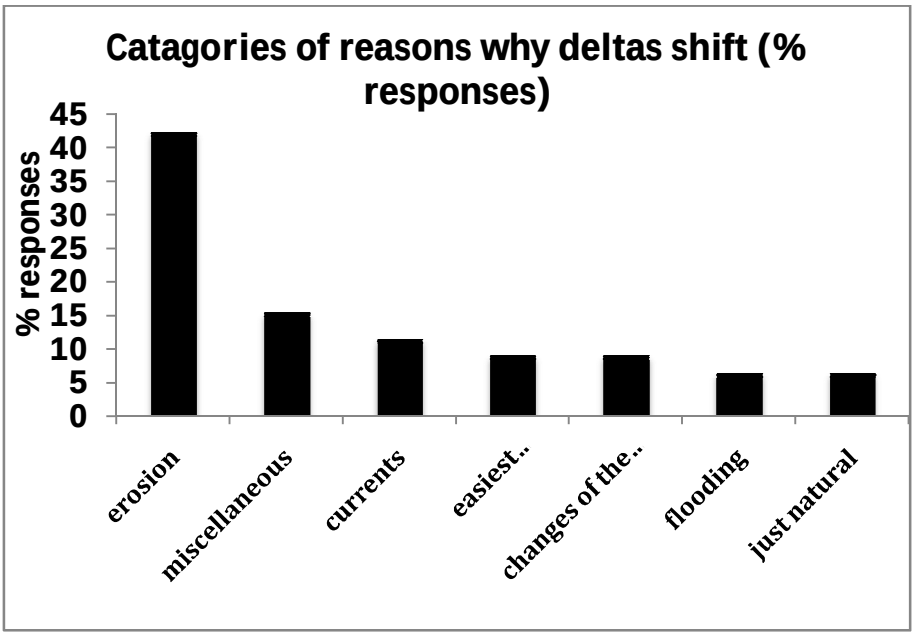
3. Results / Discussion

When asked if deltas were formed only by rivers 72% (N=100) answered true and 28% answered false. This indicates that the respondents know little about flood or ebb tide deltas that form at coastal inlets or passes and link deltas to exclusively to rivers.

Question 2, 3, 7, and 8 answers were grouped by conceptual ideas or themes presented by the respondents. Most responses fit into clear categories independently derived by each author. Borderline or unclear responses were resolved by the three authors.

In a free response question subjects were asked; why does a river change course and form a new delta? Responses were grouped into seven categories that emerged from the answers. The largest category was erosion with 42% of the responses (see figure 1). The next was currents with 12% of the responses. The category labeled, takes the easiest path / builds up at mouth, which is the closest to a correct response, had 9% of the responses. Responses that indicated a changing of the land were found in 9% of the answers. A response of it just does was given in 6% of the answers. Responses that did not fit these categories were grouped together as miscellaneous with 15% of the answers.

Figure 1.



Categories of reasons given by preservice teachers why deltas shift.

While choices of erosion, flooding, and currents shows intelligent guessing in some respect by using natural processes as part of the responses it still demonstrates a lack of understanding why a river will over time shift course and form a new delta.

With regard to why the Mississippi River is no longer building a delta 39% of the 62 respondents thought levees or some other man made action was responsible. Erosion was given as a response by 16% of the respondents. A wide range of miscellaneous and no response answers (40%) werereported. Two students indicated that they didn't know the delta was no longer building. It is important to note that three students (5%) recognized that a natural process might be in play with the following responses:

- the current Mississippi River Delta is no longer building delta material because the river is already through the building delta stage
- because it's an old river
- it is already completely built up.

While sediment reduction due to river channelization partially accounts for the Mississippi River delta no longer building, the other important reason is that the delta has built out to the edge of the continental shelf and sediment falls off into the deeper waters of the Gulf of Mexico. This idea was not mentioned by any of the respondents indicating a lack of conceptual understanding of Mississippi River dynamics and root causes of coastal erosion.

When asked if marshes surrounding the Mississippi River Delta depend on sediment from the river a large majority 88% of the 98 respondents indicated this was true, and 12% responded false to the question. This is encouraging that a connection between delta marshes and delta sediment supplied by the river is recognized.

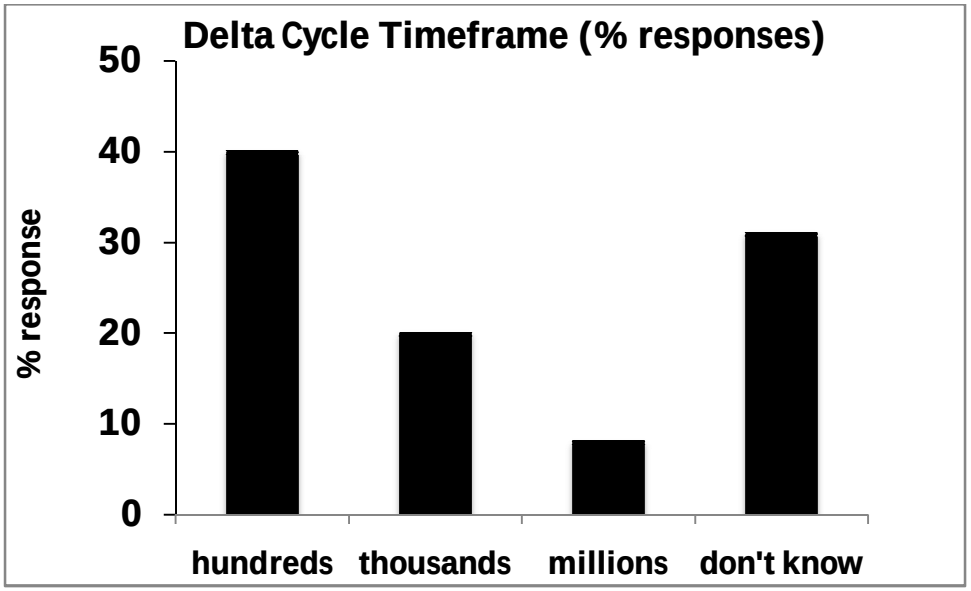
Considering the order of events in a delta's life cycle the pre service teachers were asked to sequence the following stages:

- Retreating delta
- Abandoned delta
- Delta switch
- Building delta.

Less than half 39% of the 99 respondents were able to provide the correct sequence and 60% failed to correctly sequence the distinct phases of what is called the delta cycle. This demonstrates a critical gap in understanding the natural process of a delta cycle. The various stages and what point in time a delta is in a particular phase is directly connected to wetland loss and erosion or building.

The preservice teachers were asked if the timeframe for a delta cycle was a) hundreds of years, b) thousands of years, c) millions of years, or d) I don't know. The timeframe of hundreds of years was selected by 40% of the 99 respondents. The correct timeframe of thousands of years was selected by 20% of the respondents. A small group 8% selected millions of years. Perhaps with the vast amount of media attention to the disappearing rate of wetlands the preservice teachers may think in terms of a compressed timeframe for the completion of a delta cycle. See figure 2. Further, an understanding of geological time is problematic for many (Clary, Brzuszel, and Wandersee, 2008).

Figure 2.



Responses to timeframe of a delta cycle.

The free response question why are barrier islands made of sand and not mud generated few correct answers 13% (n=85). A small percentage of answers 6% stated that sand was lighter than mud, and mud goes to the bottom.

Otherwise, there was an array of off target responses that could not be grouped. The abandoned delta phase of the delta cycle characterized by an eroding headland and flanking barrier islands is conceptualized by a loss of sediment supply thus, providing no more silt and a reworking of headland sediments by marine processes thus, washing away silt and leaving behind sand that is constantly redistributed. Based upon the answers given such an understanding is not present in this group of preservice teachers.

One of the questions on the instrument asked for an explanation of subsidence. Interestingly 54% of the 99 respondents did not respond and no response adequately described the process of land sinking, compaction, and dewatering. A few of the respondents 4% did define subsidence as sinking. It is evident that this concept was developed in this sample. A well developed conceptual understanding of subsidence is essential to understanding the dynamics of the delta cycle and the understanding of wetland loss in Louisiana.

Respondents were asked to list other deltas that are in the world and the result generated a list of 14 different deltas (see Table 1).

Table. 1 Worldwide Deltas Other Than the Mississippi Listed

Delta Listed	Frequency
Nile River	40
Amazon	23
Tigress River	4
Burdekin	4
Yangtze	2
Atchafalaya	2
Ganges	2
Euphrates River	2
Jordan River	1
Rhine River	1
Niger River	1
Apalachicola	1
Yellow River	1
Danube River	1

The clear prototypical deltas in this group are the Nile and Amazon. A strong showing for other worldwide deltas was not present. Is this a question of limited concept base of geology or geography? Two deltas listed were located in the USA and Gulf of Mexico; Atchafalaya and Apalachicola. It is somewhat surprising that the Atchafalaya was not listed more frequently since the sample population was from Louisiana.

4. Conclusion

We like to think that teachers will teach what they know. Those with a rich conceptual understanding of science related topics such a delta dynamics, coastal erosion, and wetland loss will be less likely to impart misconceptions or limited knowledge of these topics to their students. Student performance is enhanced by content that is accurate, timely, stimulating and pertinent. Content that is timely and relevant to real life can improve student motivation (Palmer, 2007).

This group of future teachers is limited in their understanding of one the most import issues facing Louisiana with national and global ties as well. Therefore, we suggest that curriculum planners and instructors of teacher education programs make sure that their candidates are presented with opportunitiesto enhance their understanding of concepts related to coastal erosion and wetland loss and the role delta dynamics play in that understanding. It is recognized that adding more course work in not possible, but a program of professional development be considered.

Further, it may be useful to expand the conceptual knowledge base and assess teacher candidates understanding of concepts related to climate change. Climate change is tied to coastal erosion because of the issue of sea level rise. Climate change is another large complex issue that requires an integrated knowledge of many science and social studies concepts to fully understand and hence teach.

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Appendix A: Student Questionnaire

1. Deltas are formed only by rivers. circle True or False
   Correct answer is False. While first impressions would indicate True, we were testing whether the notion of flood tide deltas was present in this population. In terms of sediment budget and accretion flood tide deltas are important to the stability of barrier islands. Barrier island erosion and inlet migration are an issue throughout the Gulf and Eastern Seaboard.

2. Why does a river change course and form a new delta?
   A correct response here would include the building of a delta creates an uphill slope and pressure build up makes the river seek the path of least resistance.

3. Why is the current Mississippi River Delta no longer building delta material?
   Correct responses would include leeving of the river, soil conservation retaining sediment, and that the current delta is built to the edge of the continental shelf.

4. Marshes surrounding the Mississippi River Delta depend on sediment from the river. circle True or False
   Correct response is true.

5. Sequence in order the following: # 1, 2, 3, 4
   Retreating delta
   Abandoned delta
   Delta Switch
   Building delta
   Correct response is 4, 3, 1, 2

6. The timeframe for a delta is (circle a, b, c, d)
   a. Hundreds of years
   b. Thousands of years
   c. Millions of years
   d. Don't know
   Correct answer is b.

7. Why are the barrier islands made of sand and not mud?

   Correct answer may include that barrier islands no longer receive sediment from a river source, and the physical environment of waves, tides, and wind remove silt and clays from the existing sediment.

8. What is subsidence? Explain as best you can.

   Correct answer may include the notion of compaction and dewatering of the soil, and sinking of the soil due to the weight of deposited sediment.

9. Name four other deltas in the world.

   1._____
   2._____
   3._____
   4._____

   Correct answers include any of the approximately 34 possibilities.