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LEARNING & CREATIVITY PLAN (L&C PLAN): WHO MOVED THE BEACH?

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1. Overview

Title Driving Question or Topic	WHO MOVED THE BEACH? What are the primary causes and impacts of coastal erosion, and how should human communities respond to this process?
Ages, Grades, … Duration, Timeline, Activities	AGES: 14 - 18 — 9th – 12th grade 4 LEARNING HOURS — Four 45-minute class periods, plus time for student research — 4 ACTIVITIES
Curriculum Alignment	Science as Inquiry, Physical Science, Earth and Space Science, Science and technology, Science in Personal and Social perspectives, Geography
Contributors, Partners Abstract - Synopsis	High school students working in groups of three to four learn about the primary causes and impacts of coastal erosion, and use elevation data to construct profiles of three beaches, make inferences about the erosion process, and discuss how humans should respond.
References, Acknowledgements	www.teachers.egfi-k12.org Created by the American Society for Engineering Education (ASEE), this blog aims to be both a networking site for teachers and a trustworthy source of information and opportunities. The activity has been adapted from the National Oceanic and Atmospheric Administration's coastal management lesson plans.

2. STEAME Framework*

Teachers' Cooperation	1st Teacher: Science Teaching the causes of the coastal erosion: storms, floods, shoreline erosion, other natural hazards and land subsidence. Classroom 2nd Teacher: Geography Teaching how to identify areas most likely to be affected by erosion. Classroom 3rd Teacher: Engineering

	Teaching what engineering solutions protect coastlines, which engineering solutions suit a particular type of coastline. Classroom (The three teachers can work together after the first session of the project)
STEAME in Life (SiL) Organization	A meeting with experts such as: - scientists who know how to classify waves according to their sizes And - engineers who work on the possible solutions to reduce damages and on the methods of coastal protection (natural systems and artificial ones).
Action Plan Formulation	**STAGE I:** Preparation by one or more teachers [STEPS 1-3], and **STAGE II**: Action Plan Formulation [Preparation STEPS 1-3]… Refers to the creation of this Learning Plan, by teachers in collaboration. **STAGE II:** Action Plan Formulation [Development STEPS 4-15]… Refers to the realization by the students of the activities of the Learning Plan. **STAGE II:** Action Plan Formulation [STEPS 16, 18]… Refers to the realization by the students of the activities of the Learning Plan. The support, feedback and evaluation by the teachers is accompanying throughout the implementation of the activities and not only the final result.

* *under development the final elements of the framework*

3. Objectives and Methodologies

Learning Goals and Objectives	By the end of the L&C Plan, students will be able to: - *identify* coastal erosion as a natural process and - *explain* how human activity can increase the risks associated with coastal erosion.
Learning Outcomes and expected Results	After the project, students will be able to identify options for reducing risks caused by coastal erosion, and discuss the advantages and problems associated with these options. They will be able to analyze and interpret beach elevation data, and make inferences from these data about the relative vulnerability of different beaches to coastal erosion.
Prior Knowledge and Prerequisites	Basic knowledge of the meaning of the key words: - Erosion - Accretion - Longshore transport - Dune - Berm - Beach profile
Motivation, Methodology, Strategies, Scaffolds	The main methodology of this project is based on enquiry-based learning, an active learning that starts posing questions, problems and scenarios. Students will identify and research issues to develop knowledge and solutions. Inquiry-based learning prioritizes problems that require critical and creative thinking so students can develop abilities to ask questions, design investigations, interpret evidence, form explanations and arguments and communicate findings. Students are invited to reflect on a real problem that affects our earth and, analyzing and comparing data from different beaches, they can make inferences from these data and come to some conclusions and suggestions about how to reduce the damages due to coastal erosion.

4. Preparation and Means

Preparation, Space Setting, *Troubleshooting Tips*	Seating Arrangement: Classroom style or groups of 3-4 students Maximum Number of Students: 30 Materials: •Computers with Internet access •Copies of "Coastal Erosion Subject Review Worksheet; one copy for each student or student group •Graph paper or computers with spreadsheet and graphing software Background Information: Almost half of the people living in the United States live near the coast. As the coastal population continues to grow, more people and property will be exposed to hazards caused by severe storms, floods, shoreline erosion and other natural hazards. Homes and businesses are often built in low-lying areas and barrier islands that are particularly vulnerable to storm damage. The potentially disastrous consequences of this trend became obvious during the summer of 2004 when residents of Florida were battered by four major hurricanes within six weeks, resulting in billions of dollars worth of damage. Much of the price is eventually borne by American taxpayers through federal government funds for disaster relief and reconstruction. While erosion and land subsidence (land sinking below sea level), are less spectacular than strong storms, they are just as important in economic terms. Erosion alone is estimated to cause billions of dollars of damage every year along U.S. coasts. Subsidence around New Orleans has necessitated large expenditures for pumping and dike maintenance. Subsidence in Texas, Florida, and California threatens high-value land uses and causes damages that cost millions to repair. Attempts to protect against coastal hazards can cause additional problems. Sea walls intended to protect against storm waves can actually accelerate beach erosion and reduce the capacity of beaches to absorb storm energy. As a result, buildings adjacent to the beaches are exposed to the full force of wind and waves. Human activities such as diking and drainage of land around New Orleans, ground water removal in Texas and Florida, and extraction of oil and gas in California have accelerated subsidence in these areas (see, for example, http://ga.water.usgs.gov/edu/earthgwlandsubside.html). Experience has shown that prevention is the best approach to deal with these problems. It costs much less to prevent construction in areas unsuitable for development than to provide funds for emergency response, cleanup, and reconstruction. NOAA's Office of Ocean and Coastal Resource Management works in partnership with state governments to minimize the impact of coastal hazards by • Identifying areas that are most likely to be severely affected by these hazards; • Developing warning systems and response plans to minimize human exposure to hazardous events; • Establishing appropriate building codes; and • Restoring the natural protective functions of beaches and dunes. From 1996 to 2000, the National Ocean Service, NASA, and U.S. Geological Survey partnered in an Airborne LIDAR Assessment of Coastal Erosion (known as the ALACE project). LIDAR stands for light detecting and ranging, and is part of NASA's Airborne Topographic Mapper (ATM). The ATM system uses a laser altimeter installed in an aircraft. As the aircraft flies along the coast, the altimeter scans the earth's surface in a path several hundred meters wide, and acquires an estimate

	of ground elevation every few square meters. The ALACE project collected topographic data (elevations of dunes and beaches) along U.S. coasts. These data have been used to create maps that show the relative vulnerability to coastal erosion. These maps can be used to quickly locate areas that may be severely impacted by coastal storms, to help plans for emergency response as well as environmentally appropriate development. For more information on LIDAR mapping, visit http://www.csc.noaa.gov/products/nchaz/htm/ldarmenu.htm.
Resources, Tools, Material, Attachments, Equipment	Resources: http://www.csc.noaa.gov/crs/rs_apps/sensors/lidar.htm – National Coastal LIDAR data from NOAA's Coastal Services Center http://ww3.csc.noaa.gov/beachnourishment/ – Beach Nourishment: A Guide for Local Government Officials from the NOAA Coastal Services Center http://www.heinzctr.org/NEW_WEB/PDF/erosnsum.pdf and http://www.heinzctr.org/NEW_WEB/PDF/erosnrpt.pdf – summary (23 pages, 544 kb) and full (252 pages, 3.9 mb) report, "Evaluation of Erosion Hazards" prepared by the H. John Heinz III Center for Science, Economics and the Environment http://coastal.er.usgs.gov/hurricanes/ – U.S. Geological Survey "Hurricane and Extreme Storm Impact Studies" webpage http://archives.cnn.com/2000/fyi/news/09/20/coastal.erosion/index.html – CNNfyi article, "Beaches on the brink" Reports and articles needed to complete worksheet: "Evaluation of Erosion Hazards," (Summary) April 2000 report prepared for the Federal Emergency Management Agency by the H. John Heinz III Center for Science, Economics, and the Environment. Read full report. NOAA's Coastal Hazards Assessment. National Assessment of Storm-induced Coastal Change Hazards. Beaches on the Brink. 2000 CNN report. Links to Overview Essays and Resources Needed for Student Research http://www.oceanservice.noaa.gov/topics/coasts/assessment/ http://coastalmanagement.noaa.gov/pcd/coastal_hazards.html For Educators: Labs, Lessons & Other Hands-on Coastal Geography and Environmental Engineering Science sites: The BRIDGE," an ocean of free, teacher approved marine science education resources" from the College of William and Mary's Virginia Institute of Marine Science, includes a "immerging properties" seal level investigation using data, "where's the beach" Data activity that uses data to analyze erosion and a coastal geology lab from Oregon State University. Live near a beach? Take your own beach profile measurements. (See the University of Maine's helpful how-to guide for volunteer beach monitors.) Or use the University of Hawaii's sea-level data to compare how beaches are shifting in different U.S. coastal regions. Graphing the Beach Profile. How-to guide from the education program of the New Jersey Sea Grant Consortium includes how to count bird and human tracks.
Safety and Health	

5. Implementation

Instructional Activities, Procedures, Reflections	This L&C plan can be implemented in 4 learning hours. The first lesson can be introduced by showing images of severe coastal erosion, such as that caused by hurricanes. You can visit the NOAA photo library at http://www.photolib.noaa.gov/ 1. ACTIVITY N. 1 (45 minutes): Completion of the worksheet Tell students that their assignment is to learn about coastal erosion processes by completing the "Coastal Erosion Subject Review Worksheet." http://teachers.egfi-k12.org/wp-content/uploads/2017/05/COASTAL-MANAGEMENT-REVIEW-SHEET.docx If students do not have access to the Internet, download copies of materials cited at the beginning of the worksheet and make one copy of each article available to each student or student group. 2. ACTIVITY n. 2 (45 minutes): Review answers for the worksheet 3. ACTIVITY N. 3 (45 minutes): Review the idea of the ALACE project and LIDAR mapping (which students may have encountered while researching answers for the worksheet). Ask students what sorts of beach profiles might be most resistant to wave erosion. Provide each student or student group with copies of the text file "threebeaches.txt" and instruct each group to plot each of the four sets of data on a single graph. If possible, have students import the data into a spreadsheet program (such as Microsoft Excel) and use this program to construct their graph. Detailed directions for this process can be found at http://www.vims.edu/bridge/beachgraph.html. There are three changes needed to these instructions: (a) use the "threebeaches.txt" file instead of "beachdata.txt"; (b) be sure that the format specified in "File Origin" (step 1) matches the operating system that your students are using; and (c) be sure students adjust the size of the first row so that the entire label can be read. 4. ACTIVITY N. 4 (45 minutes): Lead a discussion of students' beach profiles. Ask students to infer which of the three beaches might be most vulnerable to wave erosion. Paradise Beach and Shell Beach both have conspicuous dunes, while Donkey Beach has a lower elevation and would be more susceptible to erosion by waves. Ask what might account for the differences in the two profiles for Paradise Beach. Students should recognize that in March the beach may have been recently exposed to winter storms that increase erosion and move sand offshore, but that by September this sand could have been returned by the gentler waves typical of summer months. Be sure students realize that the offshore areas that receive eroded sand are obviously involved in these processes, and in fact are part of the total beach profile. Discuss the three options for responding to erosion threats listed in the last question on the worksheet. Students should realize that while leaving may be the least expensive option, this is often impractical where development has already taken place. Renourishment, however, is seldom a permanent solution (see http://www3.csc.noaa.gov/beachnourishment/html/human/case.htm for an

	example). Similarly, various construction options can make property more resistant to erosion, but structures such as sea walls, jetties, and bulkheads often increase erosion and shift the problem to other areas by interrupting the natural flow of sand. The Bridge Connection http://www.vims.edu/bridge/archive0500.html – "Coastal Erosion: Where's the Beach?" http://www.vims.edu/bridge/ – In the "Site Navigation" menu on the left, click on "Ocean Science Topics," then "Marine Geology" for links to resources on coastal erosion. The Me Connection Many people who live in erosion-prone areas believe that they have the right to take whatever steps are necessary to protect their property from erosion. For example, a 1998 report in the Maryland Law Review points out that more and more houses are being built just inland of sandy beaches that are generally considered to be public lands. Because sea level is rising and most shores are eroding, the ocean will eventually reach these houses unless the houses are moved or the sea is held back. The most common "solution" is to build a wall between the private dry land and the public beach. The result is that the private land is saved and the beach erodes away. In Maryland alone, more than three hundred miles of tidal shoreline have been "armored" in the last 20 years. For links to the full report, visit http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsSLRTakings.html (this report is a 2.2mb, 121 page pdf file).
Assessment - Evaluation	The assessment and formative evaluation is the completion of the worksheet and the number of correct answers given. Moreover, a continuous monitoring and evaluation is done throughout the learning plan with a special focus on the students' ability to cooperate, share proposals, solve problems and debating.
Presentation - Reporting - Sharing	Students have to write an essay explaining why they support or reject the suggested approach, and what arguments might be offered by someone with a view that opposes their own.
Extensions - Other Information	Visit http://www.mostreamteam.org/pdfs/bldusng.pdf for information on building and using a stream table to simulate erosion and other processes involving sediment transport by water (presented by the Missouri Stream Team Infocenter). Activity Extensions: Build and use a stream table to simulate erosion and other processes involving sediment transport by water. (Source: Missouri Stream Team Information)

Resources for the development of the STEAME Learning and Creativity Plan Template

STEAME Prototype/Guide for Learning & Creativity Approach
Action Plan Formulation

Major steps in the STEAME learning approach:

STAGE I: Preparation by one or more teachers

1. Formulating initial thoughts on the thematic sectors/areas to be covered
2. Engaging the world of the wider environment / work / business / parents / society / environment/ ethics
3. Target Age Group of Students - Associating with the Official Curriculum - Setting Goals and Objectives
4. Organization of the tasks of the parties involved - Designation of Coordinator - Workplaces etc.

STAGE II: Action Plan Formulation (Steps 1-18)

Preparation (by teachers)

1. Relation to the Real World – Reflection
2. Incentive – Motivation
3. Formulation of a problem (possibly in stages or phases) resulting from the above

Development (by students) – Guidance & Evaluation (in 9-11, by teachers)

4. Background Creation - Search / Gather Information
5. Simplify the issue - Configure the problem with a limited number of requirements
6. Case Making - Designing - identifying materials for building / development / creation
7. Construction - Workflow - Implementation of projects
8. Observation-Experimentation - Initial Conclusions
9. Documentation - Searching Thematic Areas (STEAME fields) related to the subject under study – Explanation based on Existing Theories and / or Empirical Results
10. Gathering of results / information based on points 7, 8, 9
11. First group presentation by students

Configuration & Results (by students) – Guidance & Evaluation (by teachers)

12. Configure mathematics or other STEAME models to describe / represent / illustrate the results
13. Studying the results in 9 and drawing conclusions, using 12
14. Applications in Everyday Life - Suggestions for Developing 9 (Entrepreneurship - SIL Days)

Review (by teachers)

15. Review the problem and review it under more demanding conditions

Project Completion (by students) – Guidance& Evaluation (by teachers)

16. Repeat steps 5 through 11 with additional or new requirements as formulated in 15
17. Investigation - Case Studies - Expansion - New Theories - Testing New Conclusions
18. Presentation of Conclusions - Communication Tactics.

STAGE III: STEAME Actions and Cooperation in Creative Projects for school students

Title of STEAME Project : ______________________

Brief Description/Outline of Organizational Arrangements / Responsibilities for Action

STAGE	**Activities/Steps** Teacher 1(T1) Cooperation with T2 and student guidance	**Activities /Steps** **By Students** Age Group: ____	**Activities /Steps** Teacher 3 (T3) Cooperation with T1 and T2 and student guidance
A	Preparation of steps 1,2	1,2	
B	Teaching - Guidance in step 3,4	3,4	
C	Teaching – Guidance 5	5	Teaching – Guidance 5
D	Guidance – Evaluation 6,7	6,7	Support 6,7
E	Guidance	8,9,10,11,12,13	Teaching – Guidance - Support
F	Organization (SIL) STEAME in Life	14 Meeting with scientists and engineers	Organization (SIL) STEAME in Life
G	Preparation of step 15	A	Cooperation in step 15
H	Guidance	16 (repetition 5-11)	Support Guidance
I	Guidance	17	Support Guidance
K	Creative Evaluation	18	Creative Evaluation