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Agribusiness and Wetlands

By Michael Melville
Pajaro Valley High School

AGROBUSINESS and WETLANDS

Summary:

This lesson was adapted directly from the Meadows to Malls unit in Interactive Mathematics Program and should be used as an example of how place-based lessons and activities may be altered and modified to apply to a specific community. Relating class activities to the community in which your students live, generates a higher level of interest and involvement.

In Agribusiness and Wetlands, students will use matrices to determine the optimal allocation of land between development and conservation based on a series of negotiated constraints. Students will extend their previous experience with solving two variable linear systems to working with three variable systems, then four and six. Students will review how inverse operations have been used to balance equations and to solve systems. They will learns how to apply all of these concepts to solving a six variable linear system using the technology available with graphing calculators. All of this work and study will be done in the context of the wetlands system that surrounds Pajaro Valley High School.

Subject Area(s): Algebra II and Linear Algebra

Grade Level(s): 10-12th grades

Lesson Duration/Instructional Sequence: 5 class periods

California Content Standards Assessed:

Algebra II:

2.0 Students solve systems of linear equations and inequalities (in two or three variables) by substitution, with graphs, or with matrices.

7.0 Students are able to derive linear equations by using the point-slope formula.

9.0 Students solve a systems of two linear equations in two variables algebraically and are able to interpret the answer graphically. Students are able to solve a systems of two linear inequalities in two variables and to sketch the solution sets.

Linear Algebra:

1.0 Students solve linear equations in any number of variables by using Gauss-Jordan elimination.

2.0 Students interpret linear systems as coefficient matrices and the Gauss-Jordan method as row operations on the coefficient matrix.

5.0 Students perform matrix multiplication and multiply vectors by matrices and by scalars.

6.0 Students demonstrate an understanding that linear systems are inconsistent (have no solutions), have exactly one solution, or have infinitely many solutions.

8.0 Students interpret geometrically the solution sets of systems of equations. For example, the solution set of a single linear equation in two variables is interpreted as a line in the plane, and the solution set of a two-by-two system is interpreted as the intersection of a pair of lines in the plane.

9.0 Students demonstrate an understanding of the notion of the inverse to a square matrix and apply that concept to solve systems of linear equations.

10.0 Students compute the determinants of 2 x 2 and 3 x 3 matrices and are familiar with their geometric interpretations as the area and volume of the parallelepipeds spanned by the images under the matrices of the standard basis vectors in two-dimensional and three-dimensional spaces.

11.0 Students know that a square matrix is invertible if, and only if, its determinant is nonzero. They can compute the inverse to 2 x 2 and 3 x 3 matrices using row reduction methods or Cramer's rule.

Assessment:

Assessment will be based on class work, homework completion and the presentation, group problem solutions and presentations, and two end-of-unit assessments.

Learning Objectives:

- Students will be able to convert a system of linear equations into a matrix
- Students will be able to solve linear systems of three variables using elimination.
- Students will be able to explain the process for multiplying two matrices.
- Students will be able multiply two matrices using a graphing calculator.
- Students will be bale to identify the steps needed to solve the linear programming problems.
- Students will be able to use the graphing calculator to find the inverse of a matrix, and to use that to solve matrix problems.

Equipment, Materials, and Resources:

- Graphing calculators, preferably TI 84's and a graphing calculator for overhead use.
- Graph paper
- Straight edges
- Colored pencils
- Overhead transparencies
- Agribusiness and Wetlands Student Worksheet
- Interactive Mathematics Program, Meadows to Malls unit

Background:

Refer to the following documents for additional information (some of these are available at the Fitz WERC).

- Pajaro Valley High School Environmental Impact Report (EIR)
- Manabe-Bergstrom Annexation Documents
- California Coastal Act
- California Coastal Commission Local Coastal Programs
- Certification Review for City of Watsonville Local Coastal Program Major Amendment No. 1-99 (Pajaro Valley High School)
- Memorandum of Understanding for City of Watsonville Local Coastal Program Major Amendment No. 1-99 (Pajaro Valley High School)

Lesson Narrative / Procedure:

This lesson plan utilizes the Agribusiness and Wetlands Student Worksheet as a base, in addition to the Meadows or Malls unit from the Interactive Mathematics Program text. Exercises should be pulled from this text as well the classroom textbook to support this lesson.

Day 1: Students will be pre-assessed on their knowledge of matrices, and their attitude and understanding of the local slough system.

- Students will read the Agribusiness and Wetlands Student Worksheet and create allocations of land to match the parameters of the problem.
- Students will construct and test parameters as linear systems.
- Students will reflect on how their work fits with what they know about matrices.
- As homework, students will practice finding intersections points for two and three variable linear systems.

Day 2: Students will share results from their homework on intersections and finding lines.

- Students will practice writing systems of linear equations in two and three variables and showing their results graphically and algebraically.
- Students will solve a non-contextualized linear system in two variables.
- As homework, students will look at a four variable systems and practice using Gauss-Jordan elimination to solve problems.

Day 3: Students will share homework results.

- Students will work on a four variable linear systems that includes developing a plan for solving and finding a solution. They will relate it to current environment.
- Returning to previous problems, students will write some linear systems in matrix form.
- Students will review multiplying two three-variable matrices, and write out the steps as a reflection of their learning.
- As homework, students will practice Gauss-Jordan elimination with three variable linear systems.

REFERENCES:

Alper, Lynne, Dan Fendel, Sherry Fraser, and Diane Resek. 1999. Interactive Mathematics Program. Year 3. Key Curriculum Press, Emeryville, CA

California Coastal Commission. 2000. Certification Review for City of Watsonville Local Coastal Program. Major Amendment. No. 1-99, Pajaro Valley High School. URL www.coastal.ca.gov/sc/wat-lcp-cert.pdf

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Jones and Stokes Environmental Consulting. 2001. Environmental Impact Report for Pajaro Valley High School.

AGRIBUSINESS AND WETLANDS

Who would have thought that so much good fortune could cause so much trouble? Well, this time it sure did for this town on the edge of a small river with a system of sloughs providing water to its agricultural businesses. It could be a lot of places, but we'll just call it River City. Actually, there were three separate pieces of good fortune.

First, when it came time to build a new high school for the area, part of the deal led to the Government's adding 300 acres of open space for the city. Other than housing the city could do whatever it wished with the property.

Then the Anderson Peat Ponds gave up its lease of 100 acres on the edge of town. They had leased the land to gather and sell peat. Because the company had not found enough of this material to make a profit for a number of years, it did not wish to renew the lease. The land was returned to the people of River City to use in any way they chose.

Finally, using the negotiations that led to acquiring the land for the new high school, River City was able to use its eminent domain powers to gain 150 acres, called the Manabe-Bergstrom annexation. So that land was also available to the city with no restrictions on its use.

Altogether, that made 550 acres of land that the city could use in any way it decided. The problem was that a city isn't exactly an "it." A city contains many people who don't always agree. And the people in River City definitely did not agree on how to use the 550 acres.

Eventually, there were agreements with the various interested parties that included the Sierra Club, the California Coastal Commission, the Local Agency Formation Commission, the school district, the River City council and the River City Wetlands Watch. One of these agreements was that this land would not be used to increase housing. The controversy over the land use centered on two opposing camps. One group wanted to use as much of the land as possible for agricultural development—that is, for fields, for storage and for processing. The other group wanted to use as much of the land as possible for renewing the wetlands---that is, for growing and replanting native flowers, grasses and other vegetation, and filtering and cleaning the sloughs themselves.

The business community won an initial victory by getting the city council to agree that at least 300 acres would go for agricultural development. The business community also thought that the more attractive sites—the Anderson Peat Ponds and the Manabe-Bergstrom annexation—should go for development, while any renewal efforts could come from the Government land. But the environmental and wetlands interests felt that some of the more attractive land should be part of the renewal effort.

The two groups finally came up with a two-part compromise.

* At most, 200 acres of the Anderson Peat Ponds and Manabe-Bergstrom land could be allocated for renewal.

* The total of (a) the amount of land Anderson Peat Ponds used for renewal, and (b) the amount of Government land used for development, had to equal *exactly* 100 acres.

Everyone realized that the city would have to improve any land used for development, putting in sewers, providing power, roads and so on. The city would also have to spend some money on helping with the renewal effort.

The city manager made a chart like the one shown here listing for each parcel how much each type of land use would cost the city. Everyone agreed that they wanted to keep the costs to River City to a minimum.

Parcel	Improvement costs per acre for renewal	Improvement costs per acre for development
Government Land	$50	$500
Anderson Peat Ponds Land	$200	$2000
Manabe-Bergstrom annexation	$100	$1000

Therefore, the matter was turned over to the city manager. She had to decide how to split the land use between development and renewal so as to minimize the cost to the city of the necessary improvements while at the same time ensuring that at least 300 acres went for development and that the two-part compromise was followed.

Now, she had tackled some complicated problems in her time, but this seemed a bit much for her to handle. So she turned the matter over to a consulting firm of city planners.

Your Task:

Your group will function as that consulting firm, working on this problem over the course of the unit. Your task for now is to find out as much as you can about the problem. By the end of the unit, you will identify the best solution.

1. Find one way to allocate the land and satisfy the constraints. Find the cost to the city for this solution even though you may recognize that it is not the least costly allocation.

What approaches to solving this problem might you have tried if you had more time? What approaches did you try that didn't seem to work?