Compost oh compost

Composting is an excellent way of reducing the amount of solid waste that goes to landfills while simultaneously producing fertilizer for gardens. Many people have home composters, about half a meter wide and perhaps a meter tall. Nitrogen is an important nutrient for plants. How are carbon/nitrogen (CN) ratios in compost related to time (t in days), particle size (P in cm), aeration (A in l air/min kg), and moisture content (M in percent)? Scientists from Spain[1] have proposed a polynomial model:

$$CN = 18.03 - 1.18A - 1.15t + 0.81AP + 0.59P - 0.56tM - 1.31t^2 + 1.17A^2$$

1. The model assumes that time, aeration, moisture content, and particle size are independent, but for the sake of mathematics we will disregard that assumption. Which of these variables might depend on each other? Discuss!

2. For one example, consider a situation in which *moisture content depends on time*: you're in a drought and so are not watering your compost, and it's not getting any rain. In this situation, let aeration (A) and particle size (P) be constants. What equation relates the rates of change of CN and M?

[1] P. Bueno, R. Tapias, F. López, M.J. Díaz, "Optimizing composting parameters for nitrogen conservation in composting," Bioresource Technology, Volume 99, Issue 11, July 2008, Pages 5069-5077, ISSN 0960-8524

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3. If moisture content is falling, with $\frac{dM}{dt} = -2$ on day 12 and the compost pile at 42% moisture, what is $\frac{dCN}{dt}$?

4. Write a full sentence interpreting your result.

5. Conversely, you might find yourself in a very rainy situation. It's been raining for a week and moisture content has increased to a constant 85%. Your particles are 1 cm across. Assume that aeration is decreasing, as mud is building up around the holes in your composter. If aeration is at 0.4 liters of air per minute-kilogram on day 4, and the carbon/nitrogen ratio is decreasing at a rate of -14, what is $\frac{dA}{dt}$?

6. Write a full sentence interpreting this result.