ASSIGNMENT I

Applied Bayesian Statistics

Table of Contents

Section I

1.1 Introduction

Recently it has been observed that fish in the river Anandi surrounding the city Vadodra has been dying at an alarming rate. This has created panic amongst the residents and they have asked authorities to investigate the matter.

1.2 Experiment

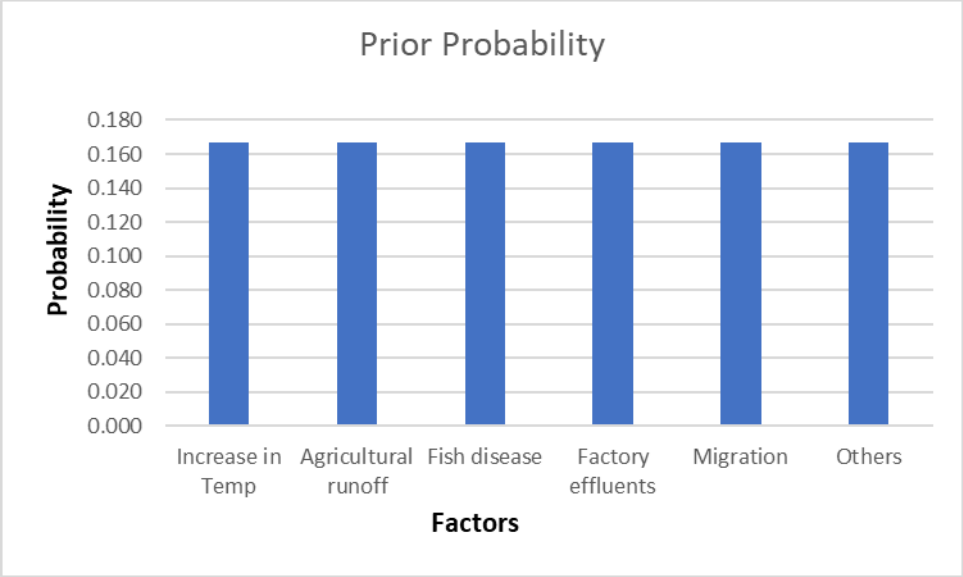
Authorities are scrambling to come up with a reason for this occurrence. They tried to study the similar scenarios in other parts of the country and came up with the five most relatable causes fitting their own city's concern. They considered rise in temperature, agricultural runoff, fish disease caused by fast spreading piscine nodavirus, factory effluents and migration of other fish species as the most relevant factors. They have added "others" as the sixth option to accomodate any other probable causes found later. Therefore, the elements of complete system for this experiment are the following:

1.2.1 Elements of complete system:

- Increase in temperature
- Agricultural run off
- Parasitic attack
- Factory effluents
- Migration of other fish
- Others

1.2.2 Initial Stage

In the absence of any specific information relating to any of the above reasons, equal probabilities (0.167) were assigned to all the probable causes.



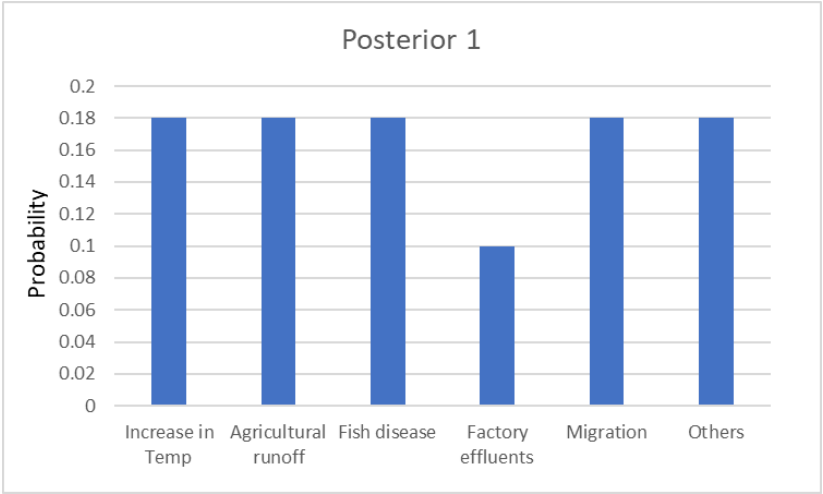
1.2.3 Aim of the experiment: To find the most probable cause out of all the possible causes for fish death in river Anandi.

Section II

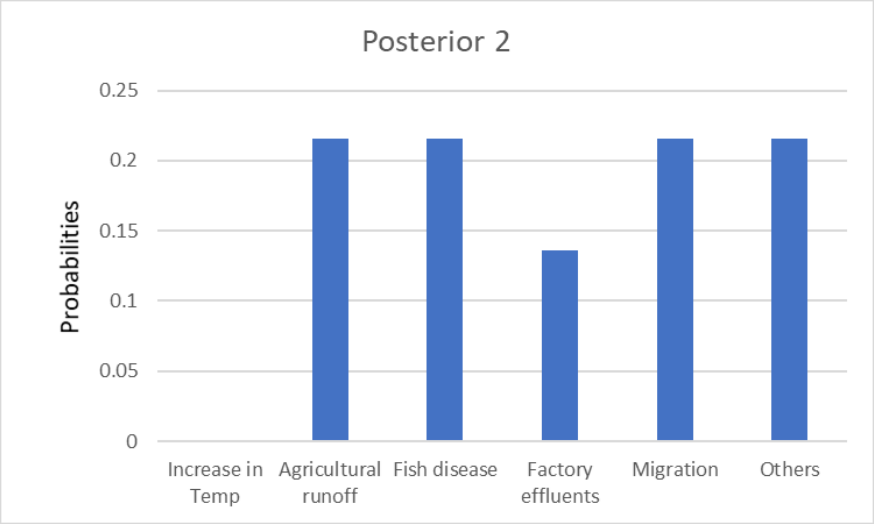
2.1 Expert Information/Sample information/Updated information:

Authorities later started diving deeper into the reign of each possible cause by contacting experts.

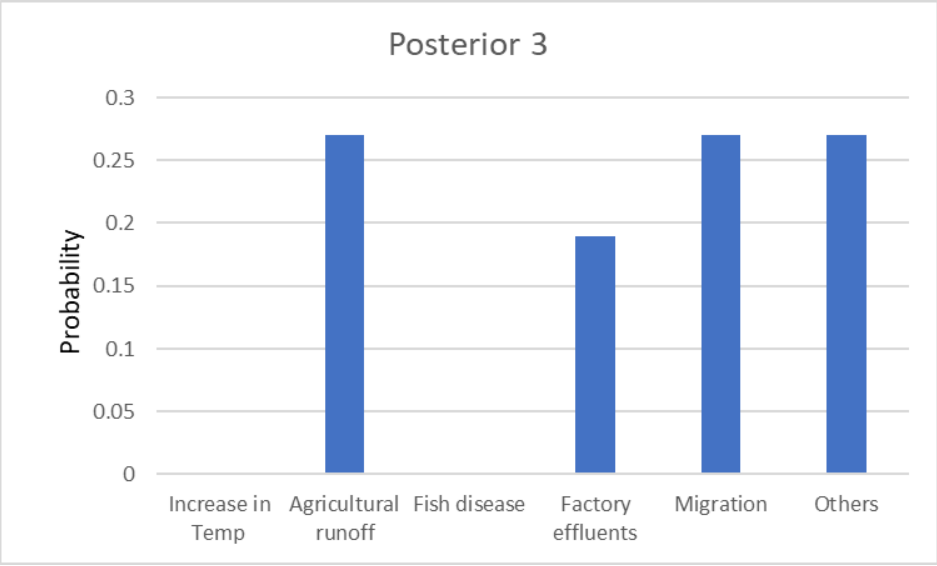
Firstly, they set up an enquiry on the quality of factory effluents outlet into the river. It was found that though the factory waste does contaminate the water and add a risk to aquatic life but the likeliness of this leading to current rate of fish mortality is very low.



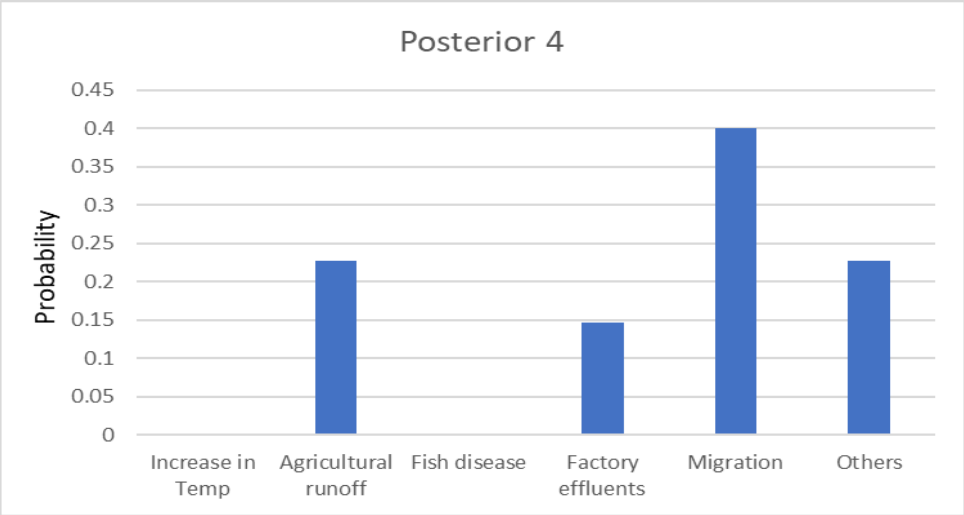
Secondly, according to recent annual meteorological reports it was found that this year's average temperature has been equal to last year's average temperature, therefore, temperature increase cannot be the appropriate reason for sudden increase in fish death this year.



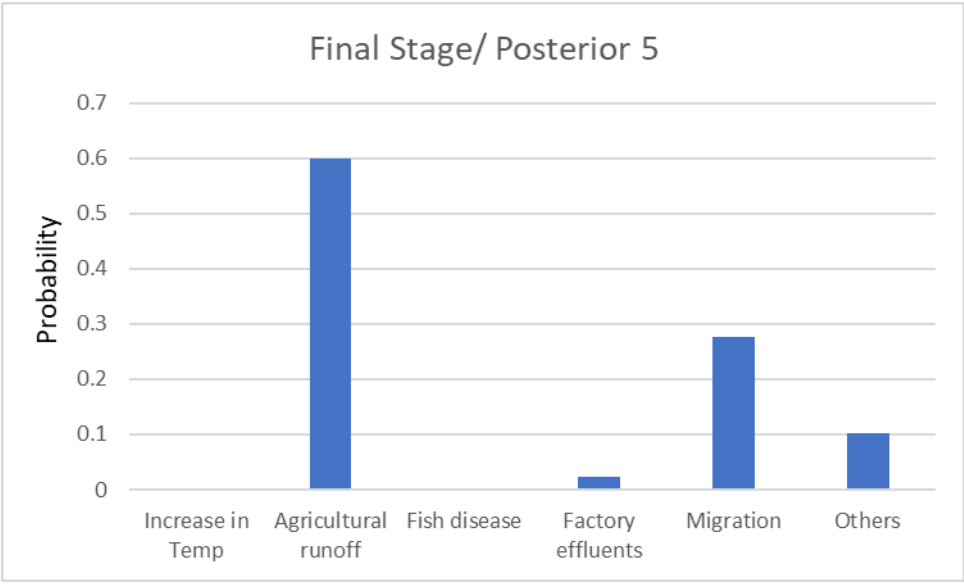
Thirdly, the authorities sent the dead fish samples to the national laboratory for checking if the dead fish perished due to the attack of nodavirus. But the test results proved that there are not any signs of nodavirus present in the dead fish samples. So, the probability of this parasite being the cause of the current high scale fish death is reduced to a negligible value.



Fourthly, it has been observed that there has been immigration of new fish species into the river which has added to the competition for food. So, this increase in fish population has the potential to cause fish kills. So thereby, the corresponding probability increases over other factors.



Lastly, it was informed that due to decrease in crop productivity over few last years, farmers have started using higher proportions of fertilizers, apparently considering it as the solution to get higher growth. Though it has led to increase in productivity, but the rains have apparently carried off the chemicals to the waterbody and has soiled it. As the water when tested for nitrogen levels showed high rise in the nitrogen levels in comparison to an acceptable range. Therefore, high concentration of nitrogen is very strong reason affecting the fish life in the river.



Section III

Findings

3.1 Final Stage:

The final stage of the experiment results in one single factor i.e. Agricultural runoff, showing up the highest probability for the high scale fish mortality in the recent time. Hence, the authorities have recommended the farmers to restrict the fertilizer usage in their farms and rather adopt more bio-friendly means to increase the productivity of the crop. Authorities also organized the meeting with soil experts with the farmers to suggest the real cause of low productivity and the recommendations for more eco-friendly measures to improve growth.

3.2 Comparison of initial and final stages of Bayesian Approach:

At the initial stage of Bayesian approach, we had equal prior probability for all the possible causes for fish kill namely,

- Increase in temperature
- Agricultural run off
- Parasitic attack
- Factory effluents
- Migration of other fish
- Others

But going through updated information we reached the final stage where one out of all the possible causes gained the highest credibility and is marked as the major significant cause of fish death in river Anandi.

3.3 Criticism of Bayesian way of thinking:

A) **Bayesian experiment without reallocation of credibility:** It is possible to use mathematical function to summarize our beliefs as an alternative to reallocating credibility. We can use the following mathematical expression to calculate the posterior probabilities.

$$\pi(\theta|\boldsymbol{x}) = \frac{f(\boldsymbol{x}|\theta)\pi(\theta)}{\int_{\Omega} f(\boldsymbol{x}|\theta)\pi(\theta)\mathrm{d}\theta} \qquad \text{for } \theta \in \Omega$$

B) Classical Approach:

The classical way would be to approach the problem from cause to effect i.e. we would have considered all the elements in the complete system and found

the probability in a classical way. In that way all the factors would be equally probable to cause an event i.e. fish kill. So, in absence of updated information we would end up giving equal weightage to all the possible causes, thereby not getting any distinct and definite solution to the problem. And therefore, authorities would have to deal with all possible causes on same footing whether they are significant or not. For example, even if the chances of fish being attacked by nodavirus are insignificant, the authorities using classical approach will try to counter the parasitic effect when it doesn't even exist. So, this would lead to wastage of time and resources. And the authorities would never get to deal with severity of actual cause with utmost importance and this could lead to more fish deaths during the time.

Section IV

References:

https://www.tandfonline.com/doi/abs/10.1080/02664769200000049?journalCode=cjas20

https://www.researchgate.net/post/What_were_the_causes_of_fish_kills_in_your_lakes_rivers_coastal_waters_and_oceans2