

(Episode 15)

(Temperature Measurements & Proxies – in English)

History of Rising Temperatures

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[In this episode we seek to understand the methods that inform us about the rise of global temperature through the centuries. The episode discusses modern climate observation practices and compares those with the use of proxies to understand temperature patterns in the distant past. All the discussion takes place in a village where the farmers are facing severe pest attack in their fields this year. Ravindran, the block development officer, aged around 40 faces their grievances. He has invited a renowned entomologist, Prof Arul Joseph (aged around 55) who explains the recent surge in pest attacks and links it to rising global temperature. Sambhu (40), Anima (35), Mizanur (55) speak on behalf of the farmers. Ravindran's wife (35) and his son Bunty(12) are the other characters.]

Prof Arul Joseph (aged around 55)

Sambhu (40),

Anima (35),

Mizanur (55) speak on behalf of the farmers

Ravindran's wife (35) and his son Bunty (12)

[The block development officer of Sunidhi village, Ravindran, is gheraoed by farmers. They are aggrieved at the administration's inaction over prolonged pest attacks that have almost ruined their crops.]

Sambhu: It is the third week sir and your administration is yet to move its feet!

Mizanur: It doesn't matter to you if we all starve to death.

Anima: When will you wake up sir! Can't you see the ruin that the pests are causing! We will all starve to death if this continues.

Ravindran: Please calm down. I am trying my best to address this situation.

Mizanur: We can all see what 'best' you are doing! You are just sitting idle.

Sambhu: There is no let up in the attack of pests.

Mizanur: Every morning I find them in far greater numbers in my field than in the earlier day. They are simply ravaging our fields.

Ravindran: Please try to understand my point. I am not an entomologist. I cannot explain why the pest attack is so severe this year.

Anima: Ento... what? Sir, you think that you can fool farmers here because they are not educated as you are! That is why you are resorting this jugglery of words!

Ravi: See, the word is 'entomologist'. It refers to a person who has specialised in the study of insects. Such a person will be of immense help to us.

Sambhu: Will he drive the pests away?

Anima: Then bring him here soon. Don't wait till we all perish along with our families.

Ravi: I have already asked the state government to send at least one experienced entomologist here. Last night I received a message saying that Dr Dhruv Saxena is likely to arrive in a couple of days. Till then we must wait. But do not misunderstand his role. He does not have any magic weapon to drive all the pests away.

Mizanur: Then why are you inviting such a useless guy? We just need more pesticides for spraying in the field.

Ravi: You all know quite well that I have distributed all the pesticide that I had under my control. But this time the pests are just refusing to go away. It's a different problem altogether. Why don't you understand! We must seek the advice of an entomologist.

Anima: Ok then...when is your ento specialist coming? Let us wait till then...say what brothers and sisters?

(Ah..ok...let us wait...murmurs all around. Sound of an incoming SMS is heard. Officer checks his cell phone.)

Ravi: Good news! He will be here tomorrow evening. So, if you want we can have a meeting tomorrow evening right here.

Mizanur: Yes-yes, we all will come. Let us know the mystery behind this intense attack on our fields.

Anima: We also need to ask whether we need to do any sacrifice before the gods...any rituals to be observed at the village temple...

Ravi: Come on! Please do not be driven by superstitions. It will do more harm than what the pests have already done. The entomologist will explain the science behind all these happenings. Then we can decide on an action plan.

Sambhu: Ok let us move now. (Announcing loudly) But my brothers and sisters, do not forget to be here by six in the evening tomorrow.

(Yes...we all will come...let us go for now...plenty of work left at home...murmurs as they leave the block development office.)

[Scene change]

(Ravindran is having dinner at home with his family. His wife Aparna and twelve year old son Bunty are with him.)

Aparna: You seem to be much tensed.

Ravi: Oh...am I?

Aparna: Your face tells it all. Any problem at office ?

Ravi: The villagers are agitated. They have a right to be so. The pest attack this season is so severe that nothing seems to work against them. We have sprayed almost double the chemical than we did last year. But there is still no let-up in the attack.

Aparna: Did they abuse you?

Ravi: Who told you so?

Aparna: Our maid servant Shyama. I had sent her to bring some items from the grocery shop. She must have passed by your office and noticed something. She told me that men and women were angrily shouting something in front of your room. I was so concerned...could not understand whether to call you or not.

Ravi: She is right. The scenario was different today. Anything could have happened if I had lost my temper even for a moment.

Aparna: What happened finally?

Ravi: I told them that I have invited one entomologist for advising us on future actions. They somehow saw my point and agreed to come tomorrow evening for discussion with the expert.

Bunty: Papa, why is the pest attack so severe this year?

Ravi: I am not an expert in this matter Bunty but I guess that it has something to do with the rising temperature.

Bunty: You mean global warming! I know...our class teacher told us about rising temperatures around the globe. He told us that all this is due to more carbon dioxide in the atmosphere. Papa, does this village produce too much carbon dioxide?

Aparna: Don't be silly Bunty! We do not have any big industrial factory around us. That means it's only the domestic households that are burning coal or kerosene. So why should we have more carbon dioxide here!

Ravi: Don't be impatient Aparna. Allow Bunty to ask any question that crosses his mind. That is the only way to learn science. (Turning to his son) Your mother is right Bunty, the production level of carbon dioxide is rather low in this village. But for increase in average temperature here it is not necessary that we produce more carbon dioxide right here.

Bunty: You mean that if carbon dioxide is produced far away then even temperature in this Sunidhi village can rise!

Aparna: Exactly so. That is the character of such gases. It can spread all over the world and trap heat. By the way, this carbon dioxide is also called a greenhouse gas. You must have learnt this in class.

Bunty: Yes of course. The analogy is with the greenhouses in low temperature areas where they trap the heat to grow plants. But one thing I do not understand at all papa.

Ravi: Give me the salad Aparna. You carry on with your question son.

Bunty: I always had this question papa....like...how do you know that temperatures are rising constantly? Who keeps the records? Are those people always right in giving us accounts of rising temperatures?

Ravi: You are absolutely correct my son! We must all agree on the dependability of the data collected and of course the analysis. Without this we cannot get the true picture of the environment.

Aparna: I remember you told me about some mountain where temperatures have been recorded steadily over the years. Where was that...it's just slipping out of my mind....

Ravi: You are right. One of the spots where such record is being kept is a volcano called Mauna Loa in the Hawaii Island. But let me correct you that what they actually specialise in is measuring the changing amount of carbon dioxide in the atmosphere. According to National Oceanic and Atmospheric Administration of America, Mauna Loa is the oldest continuous carbon dioxide monitoring station.

Bunty: Why did they choose this place papa?

Ravi: Because it is far away from human habitats. It's height is an advantage. We are through with our dinner Bunty. Do you want to watch your favourite serial now?

Bunty: No papa, not today. This temperature thing is very exciting. Just wait for me in the bedroom. I shall just wash my hands and join you in a second. Here I go papa...(Bunty rushes to the basin.)

Aparna: (Giggles) There he goes. Now tackle your son's queries!

Ravi: It's quite natural for kids to yearn for more if you can tell the story in an attractive way.

(Scene change. Bunty and Ravi are sitting face to face in the bedroom. Aparna will be joining soon.)

Bunty: So papa, what have they found at Mauna Loa?

Ravi: Well the measurement that I was talking of has been continuing since 1958. The data shows that carbon dioxide in the atmosphere is growing steadily from year to year.

Bunty: Everyone has accepted their data? No one is disagreeing?

Ravi: This is a good question. Mauna Loa is not the only carbon dioxide measuring station in the world. Other stations are giving similar results. This is the proof that Maua Loa observatory is on the right track.

(Aparna enters.)

Aparna: It seems that we are going to have an overnight session. But please do not forget Bunty that there is no holiday tomorrow. And what about you Ravi? Just a while ago you were saying that you are going through a tense phase.

Bunty: Please do not interrupt ma! We are in an exciting phase already.

Aparna: Ok. Who am I to poke my nose in such a serious discussion! Here I put my finger on my lips.

Bunty: Papa, you haven't yet told me how they are keeping the records of increasing temperatures. I understand that carbon dioxide is responsible for soaring temperatures. But who is taking the readings?

Ravi: The readings are being taken at different places in the world. Meteorological offices are taking land surface temperatures as well as ocean surface temperatures for many years now. In the United Kingdom there is Hadley Centre. It is collaborating with the University of East Anglia's Climatic Research Unit. The data provided by them is quite dependable.

Aparna: Is that all?

Ravi: Certainly not. How can you map global temperature with just one dataset? In the United States the NASA Goddard Institute for Space Sciences is partnering with National Oceanic and Atmospheric Administration to provide another dataset.

Aparna: All from the west? No data is taken from this part? I mean nothing from Asia?

Ravi: You are right. There is input from Asia as well. The Japan Meteorological Agency produces another dataset.

Bunty: Our teacher was saying something about satellites also. Do those satellites measure temperature papa?

Ravi: Yes of course! These days the satellites are also helping to estimate global temperatures.

Aparna: But all these are current records. If you want to make a comparison then you need to have records from hundreds of years ago. Is that really possible?

Ravi: The Midlands region of England has a proud record of keeping track of temperatures since 1659.

Bunty: Really? 1659!

Ravi: Yes it's definitely surprising. It was originally published in 1953.

Aparna: Wow! I didn't know that my husband is so knowledgeable!

Ravi: Come on Aparna! Everyone uses the internet today! I was surfing out of my own tension. It's true that just memorising these facts won't help me get out of this situation but still, I can at least plan wisely if I know these facts.

Bunty: So papa, regarding the historical records...

Aparna: That's all for tonight Bunty. Now move to your room like a good boy or I shall drag you there. (Bunty protests 'But ma..' Aparna is not going to listen.)

Ravi: Ok Bunty we can have another session tomorrow. The entomologist is likely to stay with us tomorrow, You will get a far more knowledgeable person in him. Now do as your ma says. Go!

(Scene changes to the office of Ravindran.)

Joseph: It is four o'clock by my watch. When are you expecting the farmers here?

Ravi: They will be here in an hour or so. Believe me Sir, they are expecting to listen something good from you. In the meantime shall I order another cup of coffee for you?

Joseph: I am your guest now. Treat me the way you like Mr Ravindran. Another cup of coffee would be just wonderful. The journey from the bus stand was quite tiring.

(Ravindran calls the peon 'Bring another cup of coffee for our guest. Yes, bring some finger chips as well. Make it fast. Ok?') He now turns to the entomologist Arul Joseph.)

Ravi: Sir, many believe that these increases in attack of pests are due to global warming. Do you think that is correct?

Joseph: Well Mr Ravindran, if you go by the scientific way then you have to attach equal importance to all possible factors. After duly analysing all the data, you can home in on one or two factors that are chiefly responsible for the event. But yes, global warming is a culprit and you just cannot wish that factor away.

Ravi: The farmers were saying that they had never seen such severe pest attack in this region.

Joseph: Human memory is short. I am not underestimating their collective memory but popular statements do not always give the real picture. There might or might not have been pest attacks on this scale in this village but take my word, no one has cared to keep a proper record.

Ravi: You have a point. You know Professor Joseph, this raises another vital question in my mind. I often see in newspapers or magazines that temperature record of the last thousand years says so...or say, based on that record the scientists are predicting this....I mean I cannot understand how is it possible to get the record of the distant past.

Joseph: (Laughs) A very good question officer! One should ask such questions to understand the real impact of global warming.

Ravi: Glad that I didn't bother you with a silly question! Just give me a minute sir...I shall just sign this file and listen to your answer.

(Ravi exhibits a bit of irritation, 'Why did you bring the file now? I told you I am busy!' The clerk murmurs, 'Actually sir, the payment to the labourers has to be done tomorrow morning. That is why...'. Ravindran signs and says, 'Ok ok, no more files now.' The signature is done and Ravindran rejoins the discussion.)

Ravi: Yes sir, tell me how they obtain the records of the distant past.

Joseph: In fact when you say that the temperature from thousand years back is known then you are not referring to a data that has been collected with your modern thermometer.

Ravi: Then?

Joseph: The method of using proxies comes in handy here.

Ravi: Proxy?

Joseph: I can understand why you are surprised. (Laughs) You had probably last heard the word in your college when your classmate bunked a class and asked to say 'present sir' on his behalf and the other.

Ravi: You are so correct sir!

Joseph: In measuring temperature proxy means something different altogether. These are indirect ways of assessing past temperatures, here one takes measurements of responses to past temperature change that are preserved in natural archives such as ice, rocks and fossils.

Ravi: I am getting more confused Prof Joseph.

Joseph: I shall explain this to you. See, for example, in cold regions, ice sheets form as snow builds up, with each year's snowfall preserved as a single, visible layer. There are measurable chemical differences in snow formed at different temperatures, so ice cores provide a record of polar temperature going back around 250,000 years for Greenland and 800,000 years for Antarctica.

Ravi: That sounds exciting! It's like Sherlock Holmes studying nature in detail.

Joseph: I must compliment you on that analogy. You are right. Scientists act like detectives to go into the records of the distant past.

Ravi: Is there any other such process to guess temperatures?

Joseph: Of course there are various ways. Growth rings in tree trunks can be wider or thinner depending on the climate at the time of growth, so fossilised trees can reveal the length of growing seasons. And fossilised or frozen pollen grains allow scientists to determine what plants were growing in the past, which can give us a good idea of the climate at the time. And by climate I include the temperature of course!

Ravi: **Certainly sir! In many museums I have seen well preserved tree trunks with distinct growth rings visible to the naked eye. Now I can understand how these can be of help!**

Joseph: Your reaction is my reward Mr Ravindran! In fact marine sediment cores provide temperature records spanning millions of years. They contain the fossilised shells of tiny marine creatures that preserve a chemical record of the sea temperature when they lived.

Ravi: Wonderful!

Joseph: In fact, to make their temperature reconstructions as accurate as possible scientists have calibrated each proxy by testing in their laboratories how it changes in response to changing temperature. However, the further back in time we look, the more sparse the proxy temperature records become.

Ravi: You mean to say that there is a lot of uncertainty?

Joseph: Look Mr Ravindran, you cannot be one hundred per cent certain here. Therefore the most reliable way to work out past temperatures is to combine different proxies – and to use data from many locations to screen out local temperature fluctuations. But enough of these proxies now. I want to meet the real people. They are not here yet.

Ravi: There sir, look...they are coming. Each of them has a question to ask you. But all relates to the pest attack.

(Ravindran orders the peon, 'Bring some more chairs here. There are quite a number of aged farmers among them. I do not want them to keep standing. Hurry up!')

Sambhu: Namaskar sir. We all have come.

Ravi: Very good. Here is Prof Arul Joseph. I told you yesterday that his area of specialisation is insects. That means he is an entomologist. He has visited several countries in connection with his research. I think he will be able to enlighten you about this exceptional pest attack.

Anima: We are being ruined sir! The pests are leaving us with almost nothing.

Sambhu: Look at Mizanur sir. He is going to marry his daughter next month. If the crop is destroyed then he will be deep in debt.

Mizanur: (Sobs) I shall have to commit suicide sir if this attack continues. (Sobs again.)

Anima: Do not be so impatient Mizanur. We shall surely find some way out of this crisis.

Sambhu: Please help us sir. We are poor farmers. Only a couple among us have completed high school education. We do not understand the terms that educated men use. We just want to save our families.

Joseph: I understand your situation. In fact I would say that you are not alone in this crisis. Pest attack is increasing all over the world with increasing temperature.

Anima: All farmers are suffering in the same way you mean?

Sambhu: But my cousin's field is not affected. His place is about four hours by bus from here.

Joseph: It is not necessary that all fields in a state or a region would suffer in the same way due to pest attack. There are several factors that are responsible. But temperature is certainly one of those.

Anima: Why does pest attack increase when temperature rises?

Joseph: It's because the rate of metabolism of insects increase with temperature. I mean they eat more, digest fast, grow at an unusually faster rate and this becomes dangerous for us.

Sambhu: Why is that sir?

Joseph: Higher rate of metabolism means that insects are hungrier. They tend to feed more on our crops. When they eat more they give birth to more offspring. Thus you find more pests every morning. By the way, what are the crops that you are growing here?

Sambhu: We do not have much choice sir. Wheat is grown on most of the fields. Some also grow paddy.

Joseph: You see, according to one study, three crops namely wheat, rice and maize is being affected. But there is one hope for you. If the average increase in temperature is more than three degrees then the metabolism of insects suffers. As I see, the temperature is one the rise now. So just wait for a few more days.

I think the pest population will suddenly come down. They might leave your field altogether.

Mizanur: What do we do till then? Should we spray more pesticide?

Joseph: No! Do not depend so much on pesticides. Try some biological control methods as well. I have advised Mr Ravindran on how to apply those control methods. He will explain it in detail.

Anima: Sir, how did our temperature rise so much that our kids are about to starve? My father-in-law says that he has not seen so many warm days in a year in his life. How did this all happen?

Joseph: It all happened due to our greed. That is all I can say in short.

Sambhu: My grandfather is still alive. He is one hundred and five years old. He says that the crops we grew earlier, when the temperature was much lower, were far better than the crops of today.

Joseph: Mr Ravindran, here is another proxy data for you! The crops can give us valuable data regarding past temperatures.

Ravindran: You mean to say someone had preserved wheat or rice grains from the days of ancient history.

Joseph: Not really. In fact records of observations of weather and climate conditions can be found in ships and farmers' logs. You can also bank on travellers' diaries. Now scientists have used these records in a very ingenious way. For example, they have used historical grape harvest dates to reconstruct summer temperatures between April and September in Paris.

Ravi: What period are you referring to Prof Joseph?

Joseph: I am talking about the period from 1370 to 1879.

Ravi: That is a big length of time!

Joseph: Yes it is. But let us turn to the crisis that our farmer friends are facing. See, I have to visit some more villages that are facing the same problem. That means I have to leave tonight.

Ravi: Tonight? I thought you will stay with us for a few days.

Joseph: I would have loved to do so officer but I am under instruction from the government to visit all those villages within this week. We need to talk to each one of them to allay their fears.

Ravi: Ah that is unfortunate. My son was also looking forward to meeting you and getting answers to his queries.

Joseph: Please don't make my heart heavier Mr Ravindran. I would really miss the company of your son. Do tell him that I shall definitely come here later in the year.

Ravi: Ok then...that's it villagers....remember what Prof Joseph has told us. The idea is not to panic and take the measures that he has advised.

Joseph: Yes please do that. Thank you friends.

(Villagers depart amid murmurs 'let's see', 'hope he is right and the pests go away')

Ravi: Thank you Professor. I would ask my men to pack your dinner because as I understand, you will not have the time to have a relaxed meal here.

Joseph: I also think so. Let me call the agricultural training centre at my next destination. They are to send a vehicle here. Let's make a move.

(Music denotes end of the episode.)