Geomorphic processes: Landforms and Landscapes
Prof. Javed N. Malik
Department of Earth Sciences
Indian Institute of Technology Kanpur

Lecture -37
Tectonic Geomorphology of Kachchh (Part I)

Welcome back. I hope you were you enjoyed the course and you enjoyed the lectures on the geomorphic process and landscape different of in different terrain, coastal then fluvial and the Aeolian. What we thought earlier that we will try to finish the part of the landscape which got changed because of the ongoing tectonic activity in Kachchh region but then we thought that we do not have enough time. But now I feel that this is an important part and we will try to cover in two lectures.

(Refer Slide Time: 01:14)

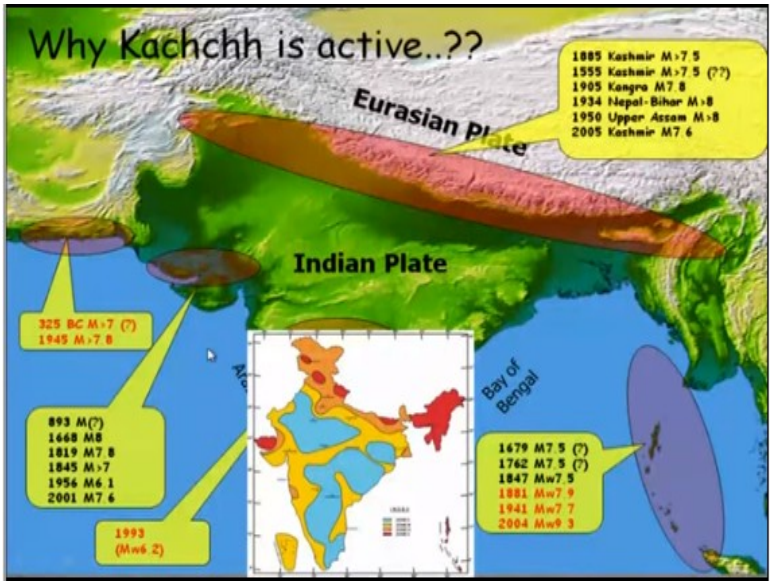
So, the geomorphology; geomorphic processes which are operating on the earth's surface is not only the one by the climatic fluctuations but also because of ongoing tectonic deformation or we can say the plate tectonism. Now if you see this is one of the famous and well known large in terms of its extent and in terms of this is I am talking about the Harrapan site in which was been discovered in Kachchh.

And so this is one of the major sites which have we have been identified from the either you can say the Harrapan Civilization or Indus Valley Civilization and this exist right now the ruins that

exists in Kahchh. In one of its island and that is known as Khadir island. Now, if we look at the terrain then that we will talk in coming slides then nobody will even dare to go and settle down there actually. Looking to the conditions but now the connectivity is good between the two islands we have roads and all that but 4000 years back no such connectivity existed.

So, this whole discussion what we are going to present here is on the landscape change in the great Rann of Kachchh western Gujarat, effect of ongoing tectonic deformation and climate change.

(Refer Slide Time: 02:53)



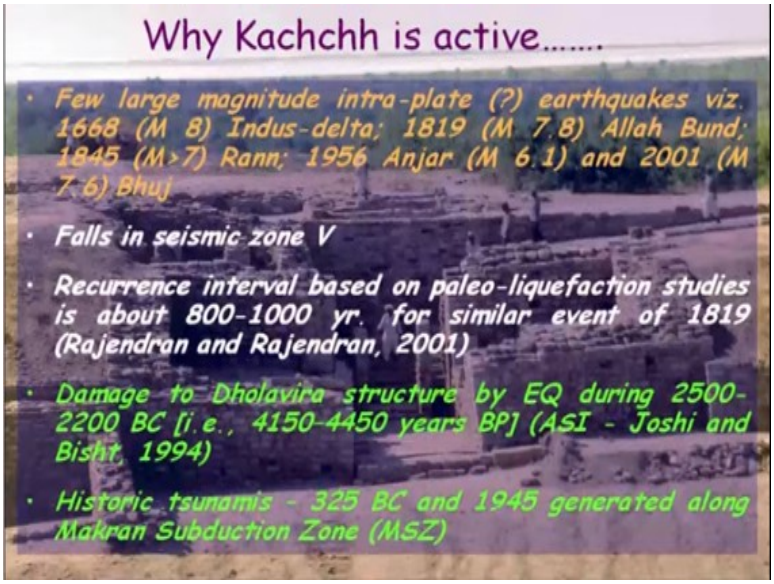
Now, I have mostly emphasized this talk because of the ongoing tectonism because that makes more sense in terms of the changes which has occurred in last10000 years. Of course the sea level change which was experienced in the Holocene time it is like the range of last 10000 years also affected the landscape change. But overall we can say that the influence of the tectonism was much higher.

Now, outside the zone of Himalaya if you look at in terms of the earthquakes and all that the Kachchh is the only region other than the area of Andaman and Nicobar in the east is the most active. And the reason is that the in historical chronicles there is an mention of many large magnitude earthquakes. So, the list which is been shown here is like the major earthquakes and

one of it was been experienced in 2001, 7.6 and other major earthquake which was experienced amongst the major ones were 1819 which is well reported.

I am not going to talk about the what about the Mahan subduction zone let us move quickly to this one. So, the landscape of Kachchh if you look at is quite dynamic.

(Refer Slide Time: 04:44)

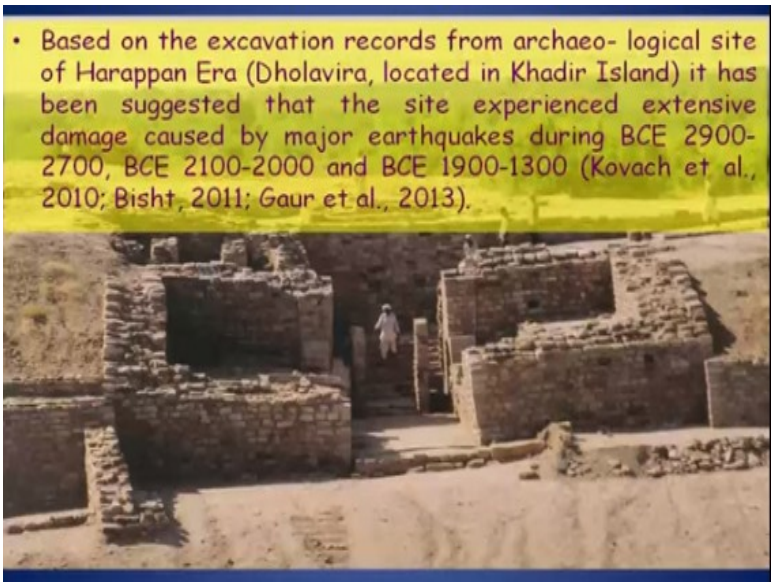


In the sense of like you have the hilly terrains, you have the flat areas and you have the most attractive landscape which is the great Rann of Kachchh. So, why Kachchh is active these are the reasons which we listed out that we have we had experienced few earthquakes in the past at falls in zone 5, a recurrence interval of between the two earthquakes is around 800 to 1000 years. Damage to Dholavira structures are the region of the area of Dholavira by earthquake history 2500 and 2200 BC.

And now this was been inferred based on the excavation which was been carried out by archeological survey of India. So, these are the few reasons why we say that the Kachchh is the active region and it has like the area was transformed and very very fast. Transform in the sense of the landscape change and the humans or the we can say the human transfer was influenced by this landscape change.

So, people were settlements were forced to leave those locations and one of the best example which we have which goes back to even around 1000 years you can talk about that how the landscape got changed.

(Refer Slide Time: 06:29)



So, based on the excavation records from archaeological sites of Harrapan era that is the site which I am talking about in the photograph which you are looking at this one is from Dholavira. So, the one is Dholavira which exist in India and Pakistan side you have Mohenjo-Daro and all that. So, Dholavira is located in Khadir Island it has been suggested that this experience that we are talking about the earthquakes which were been the signatures of the earthquakes which damage the structure identified during the excavation.

And other studies also suggest that the site experienced extensive damage caused by major earthquakes during BCE 2900 to 2700 years and other one is 2100 to 2000 years BCE and last one was around 1900 to 1300 BCE.

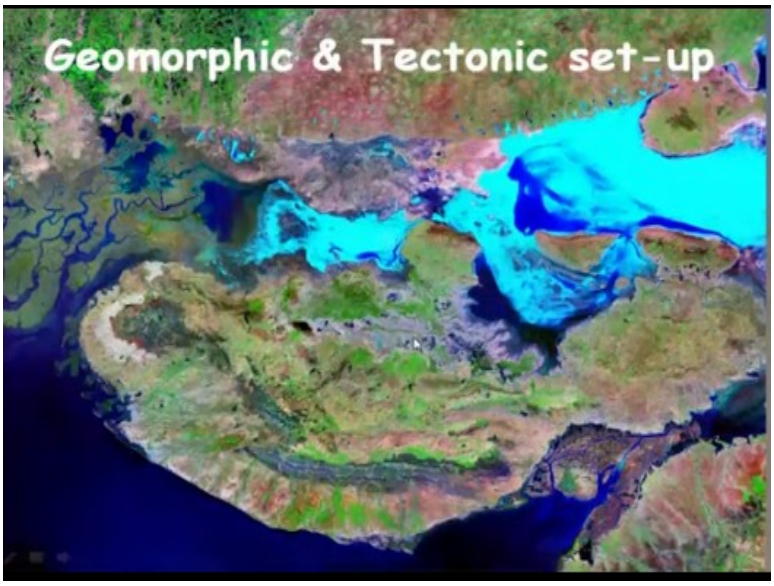
(Refer Slide Time: 07:49)

So, this is one of the important site in terms of the understanding that what happened in the past and why people were been forced to move from one place to another one. So, manifestation again now what we see is that we have like reasons of this so they we see an two different type of earthquake patterns in this region one which comes right to the surface that is the deformation is seen right up to the surface another which remains blind. And in the case of 1956, the earthquake in 2001 the deformation did not reach right up to the surface.

Now, this point of course does not have direct relevance but to the geomorphology, but yes of course the landscape evolution but the topic which we are talking about right now that that Dholavira and then the landscape change and all that. Now, to get back into the history of the earthquakes which were responsible for the damage of the sites or the change in the landscape that is important for us to identify the surface manifestation of those earthquakes.

But Kachchh is a challenging area where not all earthquakes rapture the surface or fracture the surface few of them remain blind. So, in that case what we do is we try to study the features of earthquakes which are preserved in the sediments and basically this features are related to loss of soil shear strength and that what the process we called as an liquefaction. So, I will show couple of examples of that also what liquefaction looks like and how we use liquefaction features to identify that different settlements were been affected by the earthquakes.

(Refer Slide Time: 10:00)



So, Kachchh in total you see from space then it is a very it has an diversified landscape where if you start from the north then you have this boundary which marks the boundary between the Thar desert, the great Indian desert and the marshy land. And this boundary is also this boundary of the or we can say the international border between Indian and Pakistan. And so the landscape what we have here is the Aeolian landscape and this side we are having the intertidal tidel coastal landscape.

So, you have the islands smaller islands which are here so this is Pachham, Khadir, Bela and further once here is Chorar on this side that is towards the east and then we have the Nagarparkar Island here and then main island is this one. Now, if you and this one which looks now connected between but earlier this was an separate island and this one is the (())(11:34) island. So it is a multiple islands where this one is the main island of Kachchh and what we learn when we were in school and that the kachchh name itself in Gujarati it says tortoise kachua.

So, the Kachchh name comes from that and before this landscape got changed what we see this the light blue colour is all salt and crestation. So this is part of the great Rann of Kachchh. So, thick salt accumulation is there and this all islands were surely an independent islands they were not connected through land the water was shallow sea use to be around them in the past. Even

this feature which you see here did not exist and this whole area those been occupied by then existing Arabian Sea.

And this also justifies the location of a town which was a very flourishing town not as old as Khadir which is not as old as Dholavira which sits in Khadir island here. Dholavira is Harrapan civilization but recent also even the recent very during the rajas and maharajas time this area had an settlement known as Lakhpat. Still the fort exist at and it the historical chronicle says that the ocean one of the channel which use to flow or tributary of Indus which float through this area and flowed into the Arabian sea through Kori Creek and this region had its own currency like what we are having right now going on in India is rupee.

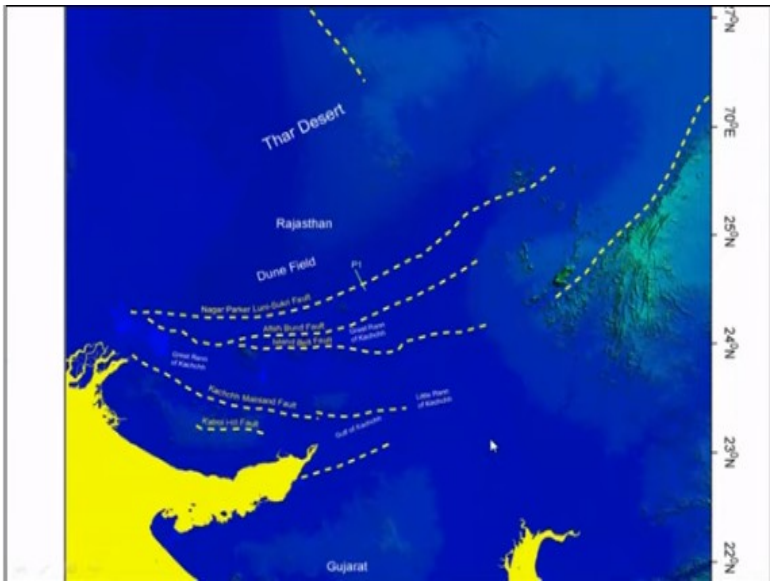
This area or the Lakhpat had an currency of kori. So, it was a very rich settlement of that time and it also talks about that this lot of paddy cultivation used to be done there but so paddy cultivation you need in fresh water but now you do not see anything it everything is in ruins and no connectivity of the channel is been seen here. Now, what we see is that there is an channel which comes from here or a stream but it is dies out in this area.

I will show the close up of that in the couple of next just but what we see the landscape change here. So, we mapped this area we concentrated on this landscapes smaller one here and then we try to understand what exactly had happened here. And also we try to look at the structures of Dholavira and try to understand that whether it preserves any signatures of the earthquake ground shaking and I will present one very a small study which we did along this fault here that is in south (()) (15:36).

So because the reason is that in 2001 this was the epicenter area it did not affect much to the Dholavira but the full fault closer to this one would have affected the Dholavira settlements. Anyway let us moved ahead and then see so, in short what we see is the landscape from north we have desert, we have fluvial marine landscape, then we have islands of course then we have the fluvial as well as the marine landscape here which existed in the past and the we have the mainland that is the your Kachchh mainland.

So, we have islands, we have mainland, we have fluvial system so everything we where we are able to see one of the most important landscape in this region is the great Rann of Kachchh.

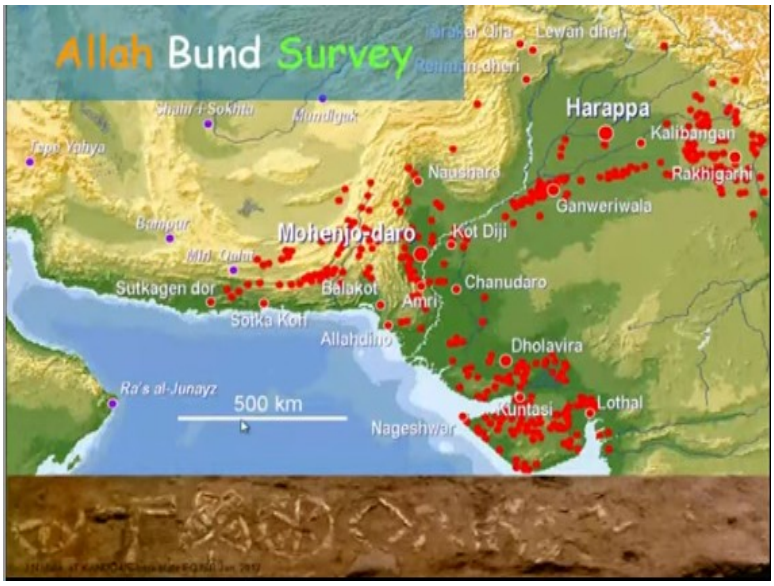
(Refer Slide Time: 16:37)



Now, if we take this shaded relief map based on this we can easily pickup that there are very sharp geomorphic boundaries one is exist here and then you have another one is here which is the part of the island chain. So you have Pachham, Khadir, Bela and then there is another one which is Chorar and this one is (())(17:08) island and this is the part of the main island. And then you are having coastal zones so it even you have the coastal zone here.

So the diversity of the landscape if you look at from desert, then to main the terrestrial and then the extra terrestrial also there. These are the fault lines which exist in this region so within the zone of lie hardly like 100, 200 kilometers you have number of active faults which is act in this region.

(Refer Slide Time: 17:45)



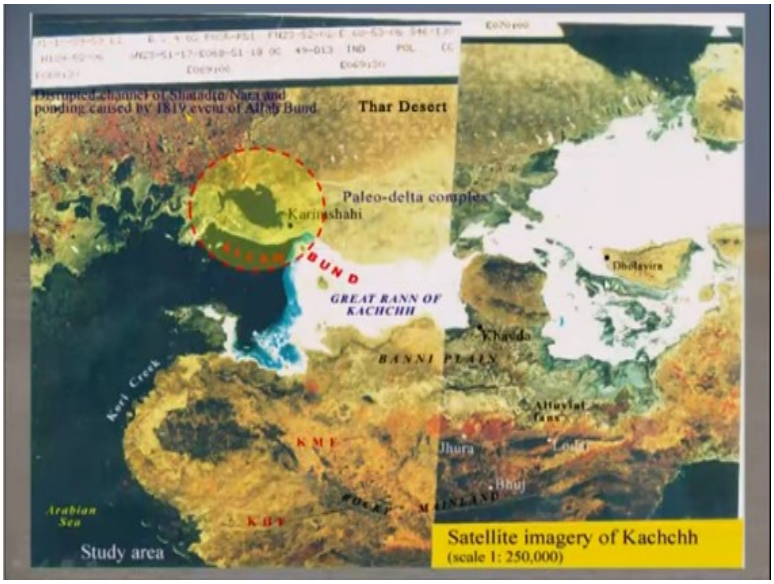
So, this is the locations which are been shown of the Harrapan settlements at different areas. So, you have the major cities like Harappa again setting further north and then you are having the major these are the major sites Mohenjo-Daro and Dholavira, Lothal and all that. So lot of concentration of the settlements where they existed in the Kachchh region and most of the settlement if you look at and what you see the clustering was along the in this channel.

And to some extent we have also in Vedic literature it talks about that that this was one of the channel which that is the Sarasvati which flowed into the great Rann of Kachchh. So, somewhere we can also say that this was Indus Valley Civilization or Sarasvati Civilization. This is the photograph of the script which they got from the one of the doors or may be one of the main gates but till date they nobody is able to decode this.

(Refer Slide Time: 19:20)

This map was prepared way back in it talks about that when the Arabs conquest of Sind 712 AD. So, what it shows that this whole area was occupied by the shallow sea and you do not see anything otherwise I was showing the marshy area in this region which came much later and this is the town which I was talking about the Lakhpat.

(Refer Slide Time: 20:07)



So, right now what we see here is the present landscape this we are having the great Rann of Kachchh the white patch is false colour composite FCC image. So, we have Thar desert which marks here then we have the this is what we have marked as a delta complex and then you are having different islands location of Dholavira and the mainland. So, this was the portion which

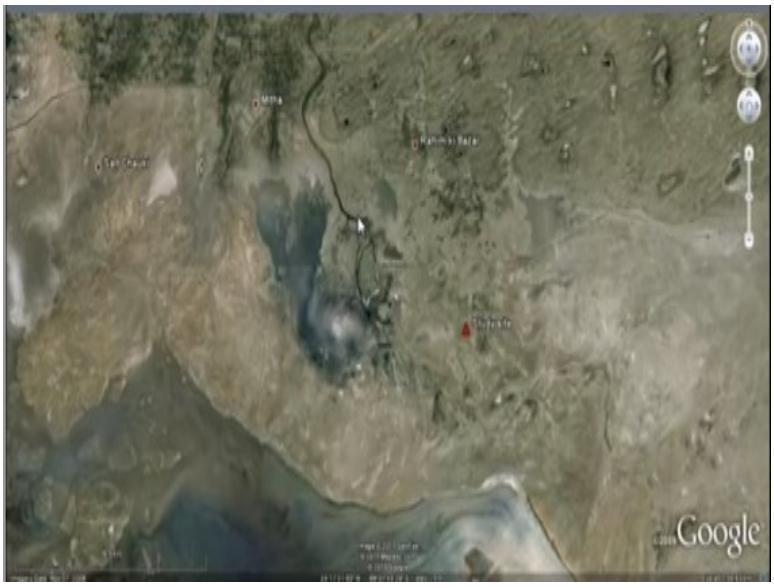
got uplifted during multiple earthquakes along this fault line and finally they this channel got disrupted which use to flow through Kori Creek here Lakhpat sits somewhere here.

So, then what we can say clearly that the Lakhpat did not or the fresh water connectivity to Lakhpat was discontinued finally by an earthquake which was been triggered along this fault line which disrupted the Nara channel. So, this is the disrupted channel of Shatatru or Nara and ponding caused by 1819 event this was an Allah Bund earthquake. And this Allah ka Bund this created a short of an bund which in Gujarati it says bund is your dam.

So dam created by Allah an actual dam so we did the mapping of this region and I will talk in coming few slides what we got. So, so this can also be like one of the landscape change if we talk about that there was an connectivity of channel which use to flow through Kori Creek but now after this earthquake there was no supply of fresh water and that was one of the reason for the decline of the culture or the settlement at Lakhpat.

Similarly, in the Dholavira used to be connected through one of the major channel of the delta complex and this is what we identified in our study.

(Refer Slide Time: 22:41)



So, close-up of this if you take Nara then you have this what you see is that in this right now it is flowing through this area but therefore there was an connectivity with the Nara channel here. But right now you do not see anything because it is which is been dying out in a form of small reservoir here. You can say the basin, small lake and no more further flow through this land but still if we go in this area you will be able to find the paleochannels through which this stream use to flow through.

(Refer Slide Time: 23:30)

So, now the present day condition is something like this so we have an huge a pond of like of course even the rain water is getting collected but a blackish water a lot of flamingos can be seen there.

(Refer Slide Time: 23:51)

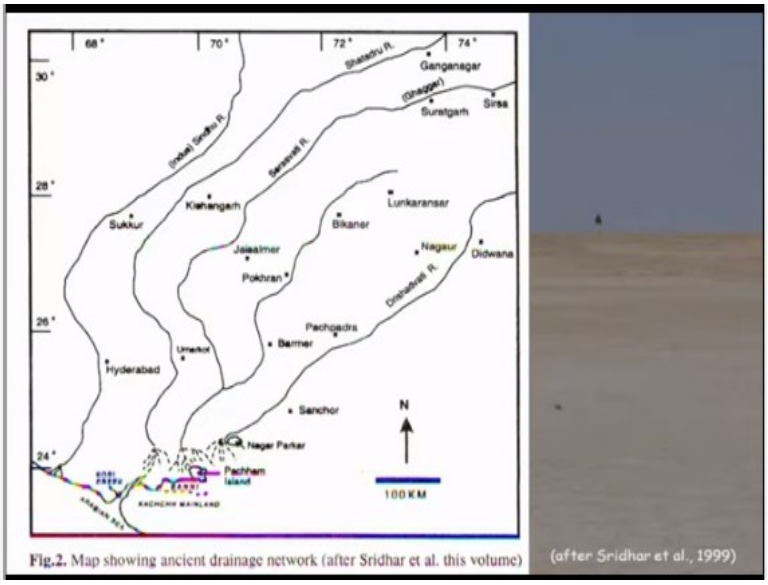


Fig.2. Map showing ancient drainage network (after Sridhar et al. this volume)

Now this is one postulation which was been made based on the satellite data interpretation as well as the historical accounts and archeological studies which have been carried out until now and based on the satellite data interpretation in this region. So, in 1999 we compile all this data and what we proposed was that the landscape what we see today was not the same. If you start from the north that is your Himalayan region come down towards the south through Rajasthan and then finally end your journey to the Rann or you can say Kachchh region in Gujarat.

So, we had like major rivers named as Deshaswathi now this names are there very much there in the Vedic literature also. So, we have the Deshaswathi, we had Ghaggar or can say this was Sarasvati, then Satadru and Sindhu. So, this were four major rivers which had they are still few of them are still flowing having the source from Himalaya. So, having source from Himalaya they floats through the Rajasthan area and met or the deposition to then existing Arabian Sea.

If we connect the sediments succession in Rajasthan the old sediment succession as well as the connectivity of the locations or the alignment of the locations of ancient civilization. Then we fairly believe that yes of course there was a major system drainage system which existed in the past in this region which allowed people to settle down along its banks. So, what we say is that the major four rivers and then we had like major four deltas which were formed at the mouth of these rivers.

(Refer Slide Time: 26:41)

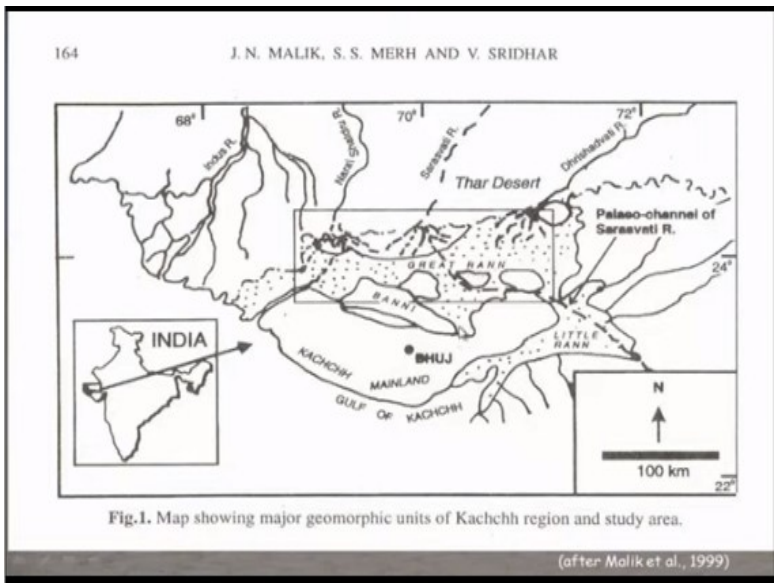


Fig.1. Map showing major geomorphic units of Kachchh region and study area.

(after Malik et al., 1999)

So, we had like the delta complex that what we suggested and we had Deshaswathi, Sarasvati, Nara and then finally the what we see as at present is Indus. But in the past we had another three deltas which allowed the people to settle down in this region so landscape is very much important in terms of the human settlement.

(Refer Slide Time: 27:13)

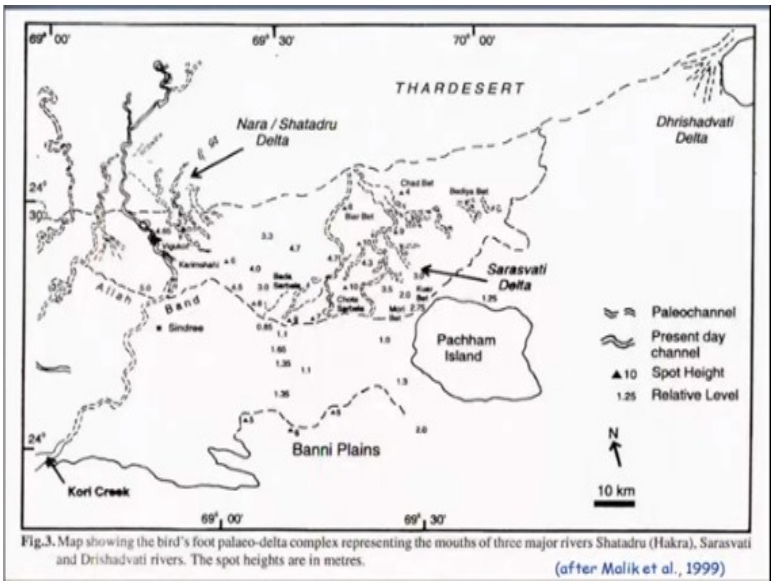


Fig.3. Map showing the bird's foot palaeo-delta complex representing the mouths of three major rivers Shatadru (Hakra), Sarasvati and Drishadvati rivers. The spot heights are in metres. (after Malik et al., 1999)

So, based on the satellite data interpretation again this was been done way back in 1999 we identified 3 or suggested 3 delta complexes or 3 deltas of different rivers. One is Deshaswathi this was not very much confirmed but this 2 are pretty well seen on and in form of the bird full delta in satellite data and we can see the paleochannels which were been picked up from the satellite images.

And then this was the channel which connected through Sindri, this is the Sindri area and this fort existed until and it was operational. This fort was operational and our port sorry the port Sindri port was operational until 1819 and got damaged during to 1819 earthquake see this channel use to connect through Kori Creek. So, let us have the detailed discussion in the next lecture. I will stop here. Thank you so much. Bye, take care.