Water, Society and Sustainability

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Lecture – 03
Socio – Hydrology

So, this is a third lecture on Socio-hydrology, the emerging theoretical framework by the natural scientist. So, who were mainly hydrologist, but now they have incorporated society or they are trying to incorporate the societal variables within the hydrological framework leading to the evolution and emergence of what is known as social hydrology.

So, I would be talking about like what is socio-hydrology and I would be trying to talk about like what are the methods and methodologies that the socio hydrologist believe in and they implied deploy and implement. And also talking about one or two cases or little bit of empirical findings a from their research. But one has to keep in mind that it is an emerging framework. So, it is a very very recent framework.

So, some of the ongoing researchers are taking place in this field there it is it has not been clouded with much research up till now, but there are some significant contributions in this field already which we would be covering and touching upon. I would request you also to go through one particular reading material that I am going to provide on this particular a paper by (Refer Time: 01:39) and her colleagues which came out in wastewater (Refer Time: 01:45) very recently in 2017.

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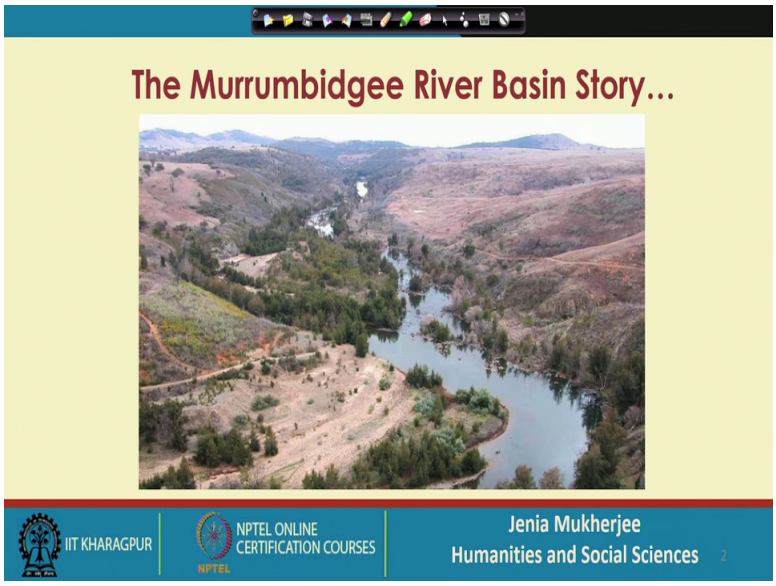

So, I will start with a particular case, a case study of a particular Australian river it is called the Murrumbidgee river. So, I will start with this Murrumbidgee river basin story.

So, let us not think about anything else let it not think about any technicalities or any other you know what say scientific or technical components regarding a river or a river basin, just let a let us concentrate on the story. So, I will just narrate a story which you need to listen to very carefully, and then I link it up with social hydrology that would be a different thing, but let us now, forget about socio-hydrology hydro social whatever let us just concentrate on the simple story.

So, in 2010 the Australian, a magazine it reported that no irrigators in these particular river basin they were up in arms against the government. Now, why were the up in arms against the government in the month of November, 2010? So, they were up in arms against the government because the government took a concerted plan and concerted action that this farmers they have to sell their water rights, they have to sell their water allocation rights to the government because the government was in a mood to revive and restore the health of the river. So, it was a direct clash between the interest and requirements of the you know the irrigators, the farmers and the riparian environment.

So, environment which was still in the backseat suddenly became very prominent. So, it directly clashed with the interest of the irrigators and the farmers who were extremely unhappy with the whole situation that you know they have now, to sell their water rights

in this particular region. So, what would happen to the their livelihoods? What will happen to their occupation? These are some of the concerned that you know that were warding these this stress farmers and the irrigators.

Now, if we really need to analyze the story we have to understand the particular narrative from a long term temporal scale. So, I will take you back to history. So, I will take you back to 100 years, maybe you know the early 90, under the early 20th century in 1900 what was happening in this particular (Refer Time: 04:32). So, if you just focus on the 1900 by following a back casting methodology. So, we will find out that during the nineteen 100s there were no dams, no wears, no infrastructure, no construction on this particular river basin.

So, it was the river was flowing at its own will and there was no infrastructural intervention on this particular river. But gradually what happened is that due to both subsistence and surplus requirement that is due to in order to provide food in order to the farmers. So, due to I mean this particular in order to accomplish the particular purpose of producing, you know increasing agricultural fertility and food production and also I mean with a very objective of producing surplus you know providing agricultural exports.

Gradually what happened is that these area or the river corridor it saw certain I mean certain infrastructural intervention, first initially in 1920s in the form of what is known as irrigation channels or irrigation canals when this entire area was irrigate. Then in 1940s what happened is that water was abstracted during low flows, 50 percent of the natural flow and in the 1950s it went up to 100 percent. So, this is how this entire river basin was actually changing.

And again if you know trace this particular period this 4-5 decades between 1950s and 1980s 90s we will find out that you know there were agricultural cultural development, there were farming development, there were irrigation facilities, there were the construction of what is known as couth uncouth water assets. That is the construction of dams wears etcetera and also whole lot of water abstraction and extraction which was taking place in the upstream of this particular river basin.

So, water was abstracted, water was extracted and people were quite happy with their occupation and both the subsistence and surplus means of the economy webbing meet.

Now, what happened is that since in 1980s the political agenda started changing. So, environment started to you know become a very important issue. So, the government thought that it is not only the economic rights of the farmers or the economic agenda that is the most important, but the environmental agenda, the agenda of restoring the health of the river and also the agenda of reviving lost bias diversity where very important objectives which need needed to be met needed to be accomplished.

So, finally, what happened is that in 2007 in the face of large looming federal election on one hand, and on other hand you know there was this protected draught which was going on finally, the government came up with a concerted plan of action that now, it is time for the irrigators, now it is time for the farmers to sell their rights, their water rights and for the sake of the environment. So, it was a direct clash as I mention between the communities, between the farming communities and the riparian environment which finally, left to massive clash between the government and this particular communities.

So, now, if we look into the hydrological changes in this particular river basin and if we can force a landscape comprising of both human settlements and human induced in infrastructures will become different from what it is now.

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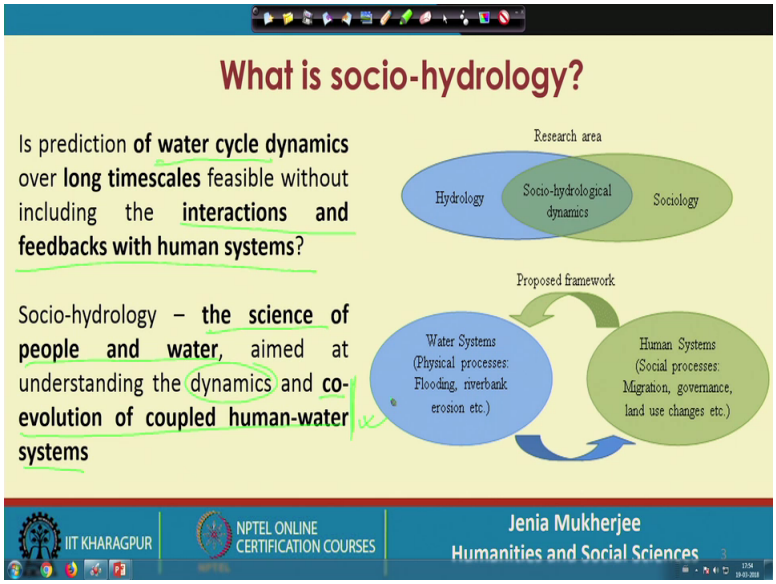

So, now the question is like how can we explain this transformation, how can we explain the hydrological change in the Murrrumbidgee river basin. So, how can we really explain the transformation, ecological transformation and also societal transformation? So, the

societal hydrological changes are this you know outcomes of the societal decision making patterns or the political decision making that have taken place since last few decades in this entire river basin. On the other hand like how hydrological changes has affected the societal decision making. So, the question is how hydrology has affected societal decision making and on the other hand how social processes or social systems had determined hydrological changes are the hydrological processes in that particular Australian river basin. So, how can we answer this questions.

So, here comes the role of socio-hydrology. So, if you really want to explain the transformation or the changes in the that that particular Australian river basin neither can we ignore the variables, the physical variables that are very important that it played in important role in the hydrological cycle or the hydrological processes. On the other hand neither can we ignored the very important role of the social variables that had also you know played a major role in transforming or in affecting the hydrological processes in that river basin.

So, is prediction of water cycle dynamics over long time scales feasible without including the interactions and feedbacks with human system. This is the most important thing which I need to highlight interactions and feedbacks with human systems interactions and feedback. So, interactions between what? Interactions between water cycle, interaction between nature or water and human system.

So, what is socio-hydrology? So, socio-hydrology is a particular science, it is a science of people and water is a science of people and water aimed at understanding the dynamics or the processes. And the fundamental statement co evolution of coupled human water systems. What is mean meant by coupled human water systems?

What is meant by co-evolution? Co-evolution means how you know this there is the evolution of two processes, but going parallel hand in hand. So, that is called co-evolution like co production, right. And coupled human water system it means where you know human and water are embedded. So, the way humans would behave the way human activities would you know affect the water cycle and intern, the way the water cycle would affect human beings or human activities.

So, this is what is known as the coupled. Coupled means which is already embedded, so which is which are not separate which are join which are you know this is the meaning or this is the significance of coupled.

So, what is socio-hydrology? It is the process and dynamics of you know through which the co evolution of coupled human water systems can be understood. And this diagram also to a great extend explains in all the relationship between the water systems and the human system. So, how socio hydrological dynamics is located in between you know hydrology and sociology. So, how hydrology and sociology to a great extend they exchange between one another and how socio hydrological processes or dynamics are taken into account.

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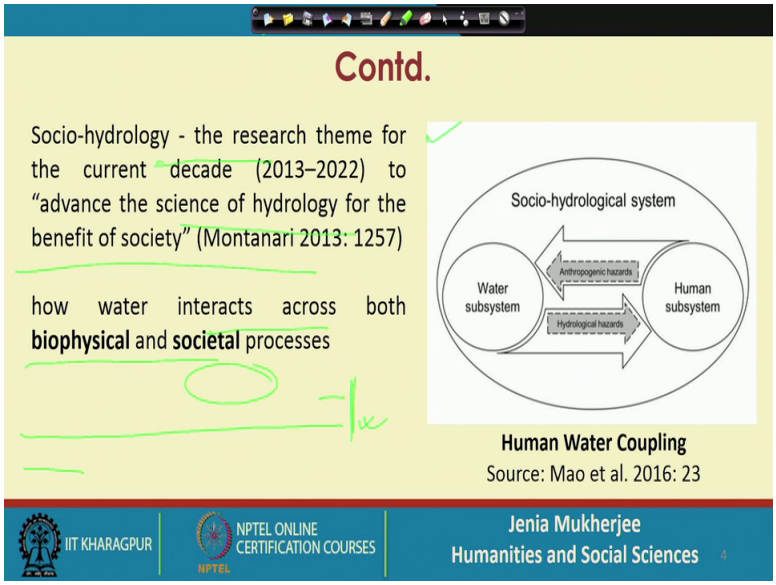

So, this is the socio hydrological system that explains the human water interaction the human water coupling more importantly. And this is very important to know that socio-hydrology it is the research theme for the current decade, inverses current decade this duration 2013 to 2020.

So, we are already in this current decade, and one of the vital research themes for water research today is socio-hydrology. And it aims to advance the science of hydrology for the benefit of society. So, no more it is interested to you know I mean reflect on only the by physical processes that water comprises of, but it also you know is interested above about the societal a decision making or the social systems or the societal processes

variables and dynamics for the benefit of the society. So, the benefit of the society, again the benefit of the society that is the key word I mean the key phrase. So, how water interacts cross both biophysical and societal processes?

Because in the previous lecture I talked about hydrology, in the previous lecture I talked about hydrological cycle. So, if you remember that you know hydrological cycle said that you know it is all about the functioning of the water cycle or the water engine weather human activity or whether human beings are present there or not. But socio-hydrology is not that particular case because socio-hydrology is very much takes into consideration that human beings you know they play vital role human beings are vital components within transformation in hydrological processes and vice versa.

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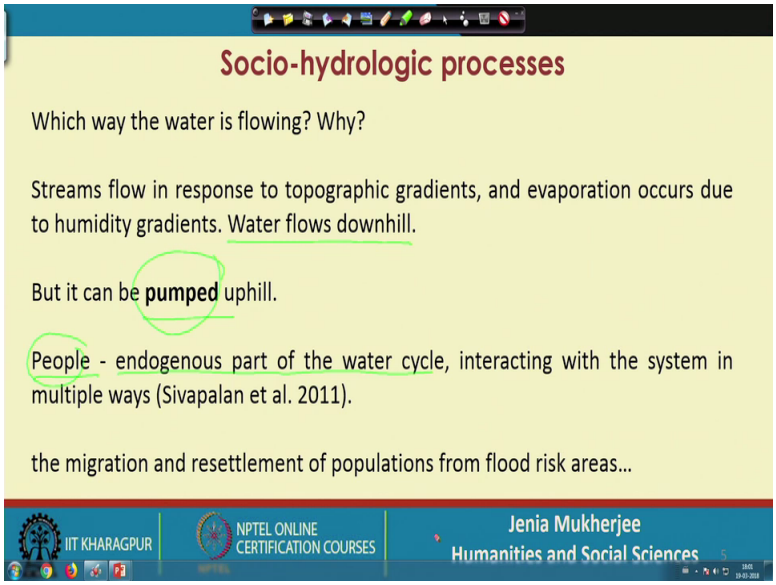

So, little more on socio-hydrology and more importantly socio hydrologic processes. So, what are soci-hydrologic dynamics or socio hydrologic processes? Now, if you raise the simple question or if you try to answer this simple question which way water is flowing, let us just imagine which way water flows.

Of course, it flows downstream down right. So, like if we tried to explain it falling you know technical understanding by falling the you know technical perception, then definitely we know that in subsurface hydrology the key driver flow and transport are always a potential gradients you know streams flow in response to topographic gradients and evaporation occurs due to humidity gradients.

So, the ideas that I mean it is quite clear that water flows down hill. So, this is the technical and physical explanation that where in which water flows water flows downhill.

Now, the question is can water flow uphill? Can water flow uphill? The answer is of course, yes it can. Now, how can it flow uphill if it is pumped uphill? So, the word the keyword is pumping. So, we can change the direction of water there can be diversion through the use of technical devices, through the use of hydraulic technique in this case specifically the pump. So, water can be pumped uphill. Now so, this pumping this is not only a physical process it is a human activity. So, it include the societal process. So, physically water flows down hill, but then when the social component gets added water can be pumped uphill. So, the flow of water can be manipulated the flow of water can be it to a great extent control by human activity.

So, here societal component becomes a very powerful element to you know to manipulate the flow of water. So, people, peoples are endogenous part of the water cycle. So, socio-hydrology gives us the understanding that one cannot you know one cannot remove people from the socio hydrologic processes. So, people form and endogenous part of the water cycle and people of course, interact with the system in multiple ways.

So, can we, I mean can we ignore the role of markets the role of policies, the role of technologies. So, what is an infrastructure? And infrastructure is you know a combination of techniques physical components and definitely the social needs. So, every a technological infrastructure intervention has a macro larger societal story and also the political and historical context and economic contest of technological intervention have to be taken into consideration.

So, we need to really see the macro picture, the larger picture where we really need to see the role of human beings, we really need to see the political social economic and also cultural context that play major role determining you know the technical choices that are made during particular points of time.

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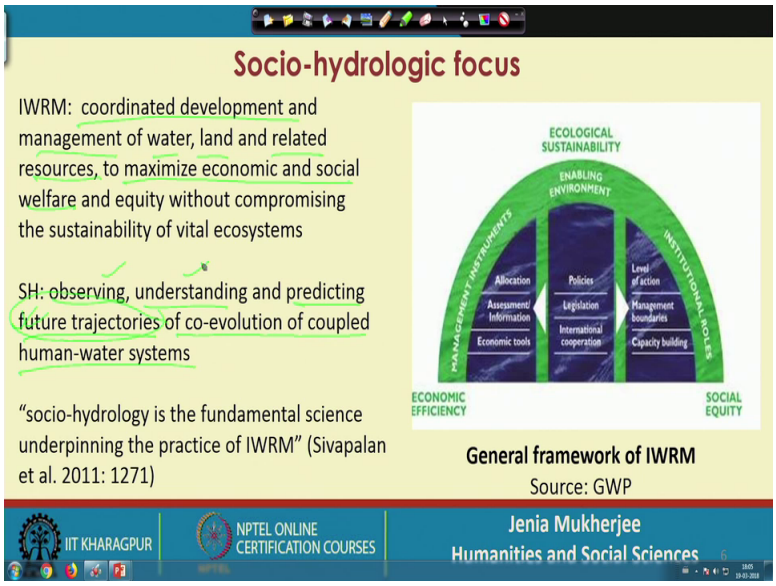

So, this brings us to the next part of our you know next part of the a lecture next important component, that how there has been move from IWRM to social hydrology or socio-hydrology. So, what is IWRM? It is integrated water resources management, and this came up this I mean is also known as a doubly is came up during the Dublin, I mean its quality Dublin principles of 1992. So, there was international conference on environment and water and, so IWRM was a described or defined as a process I mean that leads to a that will lead to coordinated development and management of not only water, but water, land and related resources.

So, for the first time it was understood that if you really need to, if you are interested about water, if you want to protect water, if you want to come up with a really fruitful and meaningful water management practices and you have to also considered land and you have to also considered the other related resources which are extremely or intricately inter related with water resources. And what was the aim? Why you know IWRM wanted to come up with a coordinated development and management of water land and related resources? Because the purpose was to maximize economic and social welfare.

So, IWRM actually rests on 3 major principles that form the overall framework of IWRM. Now, what are these 3 major principles? One is social equity, that is water should be allocated to all. So, different users, different stakeholders, more importantly the poor and vulnerable and marginalized sections of the society, some you know frameworks or

some solutions should be chocked out through which all the users will have to an extent and equal allocation and access to water resources. So, that is one of the fundamental principles within IWRM which is the principal of social equity. So, this is one.

The second is economic and efficiency, economic efficiency. So, what is economic efficiency? It says that the greatest you know use of water resource for the benefit of the greatest number of people. So, that is the principle of economic efficiency.

And another very important principal or component which is called ecological sustainability. So, what is ecological sustainability? It says that no not only the you know human world or not only the human beings, but there are also other very key important a you know species whose ecological functions are very important in that in water resources. So, those species in water resources they are. So, that they are ecological functions retain and restore that should also be taken care of. So, there should be adequate planning through which vital ecosystems within water should be taken care of.

So, these are the 3 principal social equity, economic efficiency and ecological sustainability on which IWRM restore. But one of the little bit of criticism not criticism, but I mean it is limited in the sense that it is still a planning and a management tool, that tries towards social welfare, that tries towards ecological welfare. Now, how socio-hydrology is different from IWRM? Socio-hydrology is different IWRM in the sense it is a very well developed comprehensive science which tries to or which attempts to observed understand and credit future trajectories, this is the most important thing future trajectories of co evolution of coupled human water systems.

So, it not only observes and understands the present trajectories or the present a realities, but it also tries to predict the future trajectories. So, by knowing what is happening today and not only by knowing the present, but it also will see that when will go to the cases we will see that how you know socio hydrological research also builds upon the past. So, what the scientist do?

They try to generate data using long term temporal scales. So, what happened during, the past they will collect data on that, so they will develop a data set on that; what is going on in the present they will observe that, they will understand the past events they will observe the present events and they will predict that on the basis of past and present what kind of future trajectories you know will take ship will take place. So, this is the

fundamental objective of socio-hydrology that it also predicts future trajectories by understanding and observing and looking into past events and also the present events.

So,. So, like a Sivapalan again one of the a socio hydrologist he mentions that it is the fundamental science. So, it is the fundamental science underpinning the practice of IWRM. So, while IWRM is basically a practical tenant socio-hydrology provides the theoretical framework towards you know, I mean theoretical framework for underpinning the practice in or practice of integrated water resource management.

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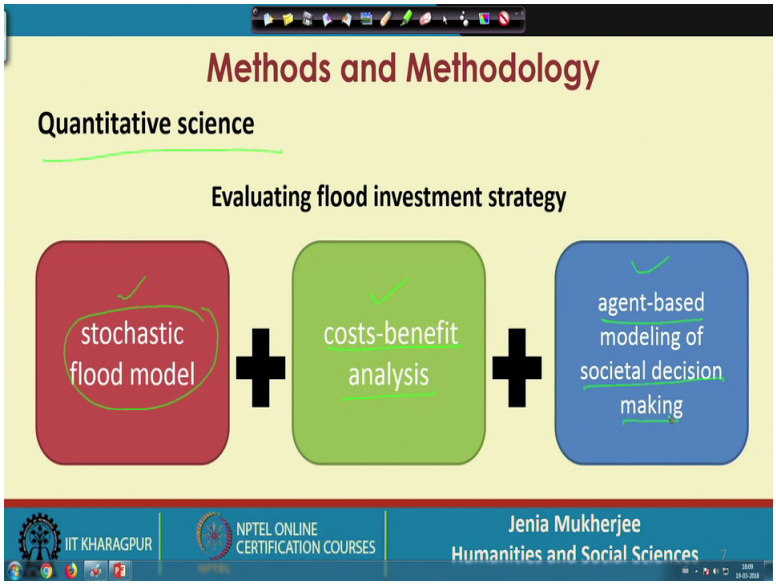

So, this is again one of the most important you know sections in socio-hydrology. Like what are the methods and methodologies followed by the scientist by the socio-hydrology. So, one has to keep in mind that though socio-hydrology the term itself you know indicates that the society is very much incorporated within hydrology. But at the same time one is keep in mind that is absolutely it is totally quantitative science there is no I mean qualitative element in socio-hydrology.

So, when will look into the limitations will see that how this is one of the challenges within socio-hydrology as well that it is absolutely depends on you know the quantitative techniques and the quantitative tools, but this is the truth that it is nothing, but you know it is nothing but quantitative science.

So, for example, like when a socio hydrologies, when a socio hydrologies would try to I mean when a socio-hydrology with try to evaluate flat investment strategy. How would he do that? So, how would his methodology be different and divergent from a hydrology, because if I hydrologies wants to you know predict and evaluate flat investment strategy, he would only be depending on the you know hard core stochastic flood model. But in socio-hydrology socio hydrologies would basically combined this 3 things that is this stochastic flood model the cost benefit analysis and agent based modeling of societal decision making.

So, not only they will depend on the stochastic flood model which is extremely technical, but they will also depend on they will also do a rigorous cost benefit analysis, and they will also take into account the perceptions the behaviors you know the other variables that play important role in societal decision making. So, in social hydrology the technical and the societal elements and variables with combined through which, and through this combination and integration this evaluation and prediction would take place.

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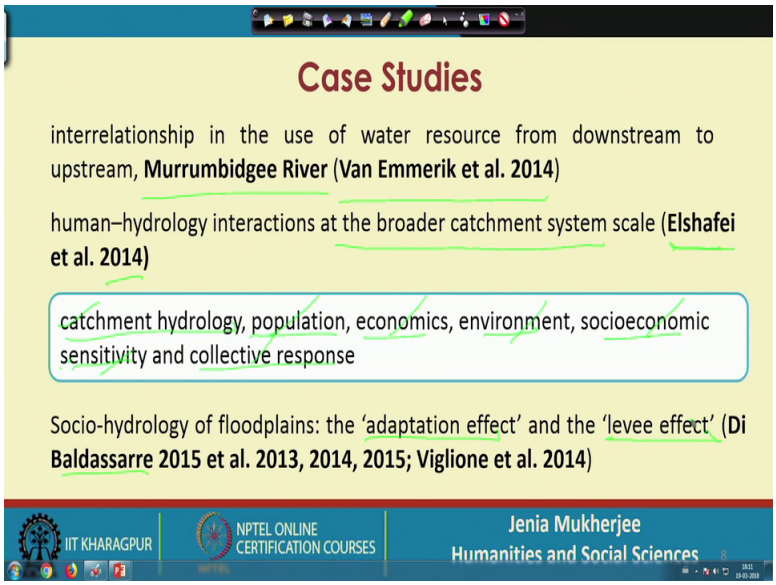

So, so we have discuss the you know the methodology. Now, let us discuss some of the case studies I will just quickly touch upon some of the case studies, some of the very recent case studies that have been published using the socio hydrological approach.

So, like this Murrumbidgee river basin case which we had already a discussed because we started this a entire I mean this a this lectures with that particular case narrative

without particular story. So, Van Emmerik et al 2014 they cover this you know Murrumbidgee river story. So, that is itself a case a through which you know Van Emmerik and his colleagues try to try to explain a changes in hydrological processes by also taking into consideration you know societal systems.

Similarly, Elshafei et al 2014 they had looked into human hydrology interactions at the broader catchment a system scale by a looking into 5 6 important parameters including no catchment hydrology, population, economics, environment, socioeconomic sensitivity, and collective response.

So, you can see. So, for example, catchment hydrology it is Hardcore you know technical component, but on the other hand like demography, economics, environment, socioeconomic, sensitivity, collective, response these things are also these. So, it combines the technical processes and technical components along with social societal components. So, that is very much evident in Elshafei case study.

Then a very interesting case study has been a done by Di Baldassarre and Viglione I really do not know how to pronounce, but then roughly this Di Baldassarre and Viglione. So, in some of the studies they had published few papers in this lines and they had done very interesting analysis or they had done actually seize of analysis on flat plain hydrology, and they have come up with certain patterns which they call the adaptation effect. And the levee effects I little bit explain a this both briefly what is this adaptation effect and levee effect.

So, what they have done is that they had done their conducted their research in the 4 flood plain, and they say like that like sometimes the communities they actually pursue this. I mean sometimes the in the communities this adaptation effect a become strong and it is adaptation effect is what like when they are is the lack of the implementation of hardcore flood defense you know management strategies or flood the defense infrastructure is not employed. Then what happens is that there is there are frequent floods, but then the severity of floods are not much, so the severity of the floods are less is less, but on the other hand floods are frequent.

But then the vulnerabilities is also less because the severity of floods is also less. On the other hand and levee effect it means that when are levees constructed. So, levees are when leaves are constructed, then what happens is that of course, the frequency of floods

get reduced but at the same time when there are floods the intensity and severity of this floods are much more. So, which leads to an increase vulnerability among the communities. So, by developing a very interesting conceptual mathematical model Baldassarre and Viglione they actually try to, they actually try to you know predict that when a the communities would actually pursue I mean when there would be the adaptation effect or when there would be the levee effect.

So, they a they did lot of you know they use very interesting sophisticated to quantitative techniques through which. And they will also use simulation and they also you know included fictive time series and all that to designate a that which pattern will be important at what particular points of time.

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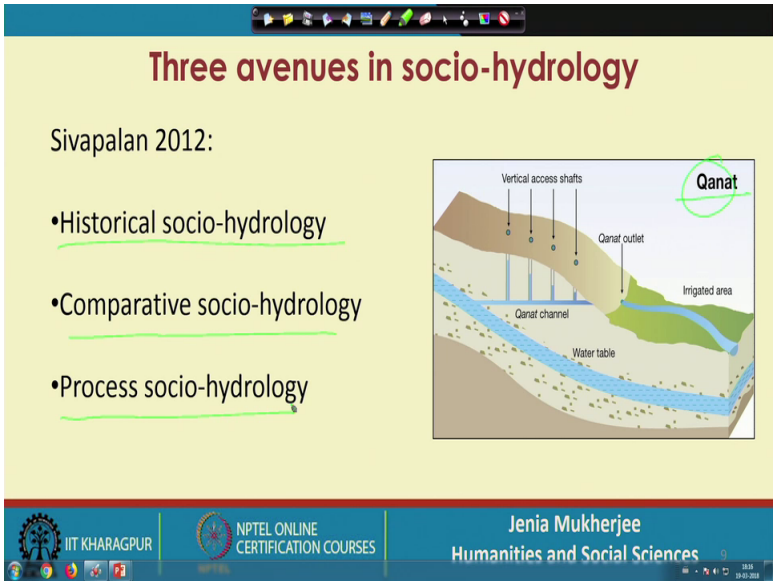

So, alike three avenues in socio-hydrology. Sivapalan in one of his a papers he talks about that there are three major avenues in socio-hydrology which can actually make socio-hydrology extremely comprehensive.

So, what is these three avenues?. So, one is historical socio-hydrology, the second one is comparative socio-hydrology and the third one is process socio-hydrology. So, first let us focus on historical socio-hydrology.

So, what is historical socio-hydrology? So, here the socio-hydrology is actually they try to depend on the data related to events of the past, because they argue and they

understand that you know even ancient civilizations, grew, they evolved and also decline and collapse due to changes you know in the coupled human water interactions. For example, if you take the example of ancient summit, then we very much know that you know one of the reasons behind the decline of collapse of the Sumerian civilization was that that like a there was there were raising water tables and there was also salinization due to due to extensive irrigation.

So, they say that you know a this historical element should be taken into consideration. And they also for example, they also talk about like how across different historical periods of time different water governance strategies had evolved and different water technologies had also evolved. For example, in Iran there had been the development of Qanat. These are very interesting you know water structures where actually you know water can be kept from the ground, but there is no need for pumping. And Iran I mean this Qanats it these had survive the test of time.

So, socio-hydrology is talk about you know the incorporation of the historical data the incorporation of historical frameworks in their research. So, that they can have a long term understanding, long term you know trajectory of how things went on. So, then they can really come up with very comprehensive data sets. So, this is one.

The second one is comprehensive socio-hydrology. So, what is comprehensive social hydrology? So, it means that for example, like the data that have been generated for a particular catchment then again data set generated for another particular catchment, these two data sets are multiple data sets across multiple catchments can be compare.

And what is the purpose what is the use of this a comparative socio-hydrology? Because if this data sets across multiple catchments for example, can be a compared then the socio hydrologist would be able to in a map these special variations and the regional differences which also which are also very important for this particular field of socio-hydrology.

And the final one is process socio-hydrology it is nothing more, but you know it here process socio-hydrology means that you know, so a process social hydrology it means that there should be rigorous understanding of the process through routine monetary. And so all the micro data sets along with the macro picture should be very much there so that

you know the processes can be taken note of can be accounted rigorously and in enormous details.

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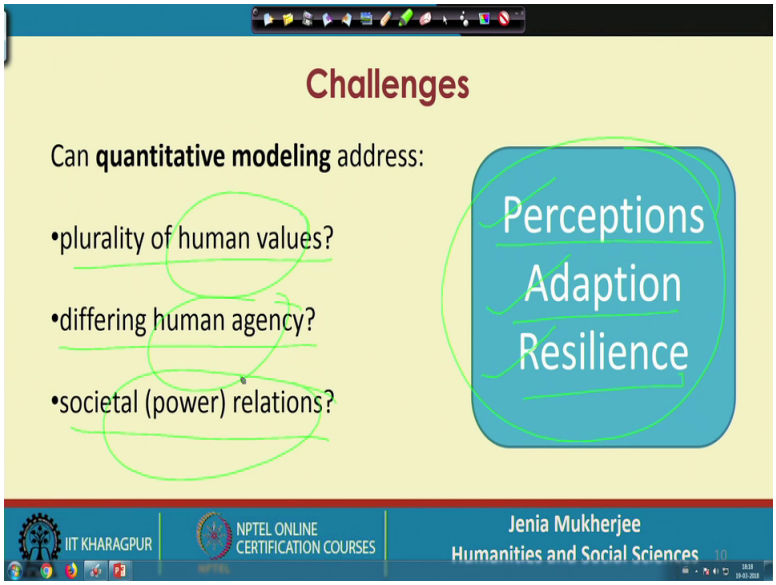

So, finally, like, so we are discuss in detail about what social hydrology is all about, why is it important and how it absolutely depends on the quantitative methodology. Then the final thing is that the major shortcoming or the major challenge in socio-hydrology is that, if you raise this particular question can quantitative modeling address plurality of human values, differing human agency, societal power relations. How can you know all these important parameters like perception, like adaptation, like resilience can fit within a quantitative mode?

How can that fit within a typically you know developed or conceptualize quantity model, because perceptions of communities adaptation skills of communities and finally, resilience of communities will differ across communities in different areas, in different localities, across different temporal scales. So, you can never actually come up with universal predictions by doing some research on a particular community at a particular location during a particular historical time. So, these things perceptions, adaptation, resilience similarly human values human agency power relations this can never fit into quantitative model.

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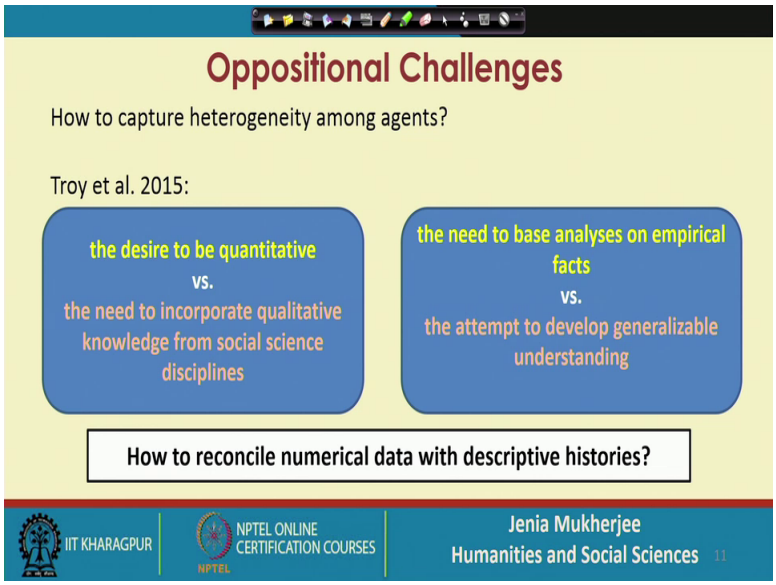

So, socio-hydrology actually you know it suffers from what Troy says, Troy et al you know says in one of the papers published in 2015 that you know it suffers from oppositional challenges.

So, on one hand the desire to the quantitative versus the need to incorporate qualitative knowledge from social science. On one hand the need to base analysis of empirical facts, on the other hand to attempt you know the attempt to develop generalizable understanding. So, these are the oppositional challenges that socio-hydrology is encountering today. And these you know, so this brings us to the question that how to reconcile numerical data with descriptive histories.

So, if you have descriptive history is can descriptive history totally fit within a quantitative model can this numerical data you know, can data on descriptive histories, I mean how it can be reconcile how socio hydrological reconcile numerical data sets within an or with descriptive histories.

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So, yes. So, these are the references and to end, I mean I would just say that this is the challenge a within socio-hydrology that actually now, would enable us to look into are there alternative frameworks that has rigorous qualitative models that has developed rigorous qualitative analysis and qualitative frameworks you know to. And that that had developed some conceptual tools through which different needs and different perceptions, different capabilities of different social stakeholders across spatial and temporal scales can be taken into consideration.

So, social hydrology also it seems not to be a very comprehensive or complete you know scientific framework though you know it is still very I mean I mean it is its close to compositeness, but at the same time there are some limitations in it which were discussed. But then it would provoke us you know then it would enable us to think that whether there are other alternative frameworks through which qualitative, through qualitative insides through qualitative frameworks things can be understood and analysis.

And that would lead us to the next lecture which would be on hydro social that how hydro social help us to go beyond these quantitative modeling within so, that you know that is practiced by social hydrologists to captured you know deeper details and to captured larger relatives.

Thank you.