LSU Institute for Energy Innovation Webinar Transcript : *Assessing CO_2 Geologic Storage Impacts on Louisiana's Water Resources and Environment*

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Brad Ives
Good morning and welcome to the Louisiana State University Institute for Energy

submit questions through the Q and A button at the bottom of the screen. I apologize in advance if we run out of time to answer everyone's questions because we'll be concluding the webinar at 10:40 Central time.

And now I want to introduce Dr. Frank Tsai. Dr. Tsai is the Chevron Professor of Engineering in the Department of Civil and Environmental Engineering at Louisiana State University. He

The concern of the CO_2 geological storage has been discussed a lot. The figure to your left, I can show you that when you have a CO_2 injection well into the deformations and the potential leak of the CO_2 can go through around the casing of the CO_2 injection wells or the existing oil and gas wells. Those CO_2 can surface up to the surface direct through the air or sometimes they will go through some shallow aquifers, may be interacted into some lakes. Sometimes the geology is not perfect for CO_2 storage. Sometimes you might see the caprocks missing. Somewhere the CO_2 might be able to leak. And also, maybe there's a geological fault, for example, as a line over here, could create a passage for CO_2 to leak to the surface or to other groundwater systems. Then those CO_2 can be leaked into the abandoned wells or maybe leak into the shallow groundwater wells. So those are the concerns generally and the public want to know how and why the CO_2 could leak to near the surface.

In terms of Louisiana, as you can see the figure to the right, that's the Mississippi River Delta Plain, which you can see lots of growth faults and salt domes and that will create lots of build complexity of geology when we have this CO_2 injection in this area. So our project basically is talking about, this is a two-year project, the project team members, including me as a PI, and then we have Chris Kees at Civil and Environmental Engineering, a co-PI, and Dr. Xu from the School of Renewable Natural Resources as a co-PI, and Dr. Ahmed Abdalla as a co-PI. Each of us doing different things, but at the end of the day, we will combine all our research together. Our research is really focused on the Lake Maurepas, which is in the center, as you can see. The project goal is really develop the baseline information on geology, groundwater, carbon budget, land-surface deformation, and the scenario-based CO_2 transport simulation to assess potential impacts of CO_2 storage in Louisiana for porous rocks, drinking water, water supplies in the environment. So pretty much I'm working on the Module 1, which is look into the geology and the groundwater categorization. And Dr. Chris Kees looking into the CO_2 modeling in the geological formation, and Dr. Xu look into the CO_2 monitoring in the lake of Lake Maurepas. Then Dr. Ahmed Abdalla using the InSAR and GNSS looking into the potential land surface deformation. Now all the information will come together into the Lake Maurepas area.

All right. So the reason we are interested in Lake Maurepas is because we know they are going to have CO_2 injection in the lake, and based on our searching through the internet, we know that the Air Products has completed a multi-millions seismic survey around the lake, to the lake. And also there are two Class V test wells being approved for drilling. You can see that one classified test well in the north, another one in the south. Their depths will be more than 8,000 feet and it is expected that to have 12 to 16 CO_2 injection wells on the lake and expect to start a CO_2 injection 2026. So this study is two years, so will be finished, provide some baselines around 2025 or early 2026. You know, that's before, provide some baseline information before the CO_2 be injected in 2026.

To understand the CO_2 injection, the first question is that where are fresh water zones and where are potential CO_2 injection zones? We're looking into a oil and gas well, which is a serial number 196347. This is electrical logs from depths 2,200 feet all the way to the depths 9,000 feet. So as you can see through an analysis of the diesel electrical logs, you will see the fresh water zones basically is above 1,000 feet. You will see the local aquifers, Gonzales-New Orleans aquifers, Upper Ponchatoula aquifers. Below 1,000 feet, you will start to see the saltwater aquifers, all the way down to Abita aquifer. It's very interesting in this log that the depths around 2,700 feet and 3,100 feet, you still have fresh water, which is the Covington aquifers and the Slidell aquifers. Then you keep looking down, you will see the huge thickness of permeable rocks starting from around the 3,600 feet all the way down to the 8,000 feet. So you can see those permeable rocks basically are sand and water and there's a potential more than 4,000 feet in thickness you can have a potential CO_2 injection. Below 8,000 feet, which basically is a shell-based formation, and when we look into those formations, those CO_2 injection zones basically is in the Miocene Jasper Formation. And by we look into the relative shallow aquifers here, below the 1,000 feet, will be the Chicot Formation, and in between will be the Evangeline Formation.

So once we identify the drinking water and the fresh water zones, then we look into the water well electrical logs. You can see those are the electric logs we already analyzed surrounding Lake Maurepas. And this Ta-435 well, which is in the Tangipahoa, tell us that we have these freshwater aquifers 1,000 feet and above, including Gonzalez-New Orleans aquifers and the Upper Ponchatoula aquifers. However, we do see in this area we have a freshwater Covington aquifers and the Slidell freshwater aquifers down to the 2,400 feet and the 3,000 feet. Looking at the south of the Pass Manchac over here and you will see the freshwater aquifer around the 1,000 feet. And you do see the freshwater around 2,800 feet, which is the Covington aquifer. And those waters have been pumped for human consumption.

This is the slides show you the groundwater pumping wells around the Lake Maurepas in terms of depths. So I specifically looked into the two pumping wells over here in the east of Lake Maurepas. You have a 2,950 feet and a 3,000 feet. And you look into this Saint John Baptist for the Baptist Parish wells, you will see they actually pump freshwater out of Covington aquifers, but majority of the pumping wells will be on the northern area of Lake Maurepas.

So to understand the groundwater impact and the environmental impact, we developed a workflow for large-scale, high-resolution groundwater modeling. You can see we starting from the well log data collection or groundwater use collection, we developed technologies to develop a geological model. Then we use MODFLOW 6 for the groundwater modeling, and at the end, we developed a high-resolution groundwater models for groundwater analysis and management. And this work is very tedious and take around like 10 years to complete this framework, and that involve many LSU graduate students to make this workflow possible.

So we look into the data first. So starting 10 years ago, we start to collect a huge amount of driller's logs and the electric flows down from Louisiana and we expand our work to the neighboring states, the Texas, Arkansas, Mississippi, Tennessee, Missouri, and so forth. So

vertical cross-section over here. So we do see some discontinuity of formations within the Lake Maurepas and surrounding Lake Maurepas. So that will be required a further investigation on those geology settings.

Then we created a groundwater model based on this current geological setting. We have pumping wells for the entire Louisiana and we do the model calibration and we use Parallel MODFLOW 6 unstructured grid. The groundwater model we have is around nearly 4.4 million 3D cells. We run 18 years. If we run one single model, it take about 15 hours or nearly 16 hours. However, if we run parallel, computing in LSU supercomputer, it only take about two hours and we get a very good calibration results. So the next step will be really analyze the groundwater levels around Lake Maurepas. This groundwater level just show you the lowest groundwater level on December 2021. You can see the height, the pumping within the state is in the Baton Rouge area and we also have a high groundwater pumping in Sparta aquifers and also in the Chicot aquifers. Some pumping, you can see the cone of depression in the New Orleans area and figure to the right just show you the historical groundwater pumping in Baton Rouge has been decreased more than 300 feet over the years.

So that's the Module 1. Now we build a geological model and a groundwater model. Then we will talking about this Module 2, Dr. Kees' research on the CO_2 transport. Basically he will going to develop and verify a high-resolution Finite Element Method to represent the inject into underground, we will see the difference of land formation, which will be kind of different from this baseline information produced by Dr. Abdalla.

All right, so what are our next steps? So we will first analyze the geology structures and the groundwater flows for Lake Maurepas areas. Then we'll use this information, give this information to Dr. Kees to develop a high-resolution Finite Element Method for CO_2 simulation. Then Dr. Xu will continue to understand what CO_2 or carbon budget, continuous CO_2 monitoring and analysis. And Dr. Abdalla will continue the land surface displacement analysis for this year, for the rest of years and this year's. Next year is for with the satellite data.

is really important and it's the bottom line for what we do. And that is, quote, "The responsible conduct of research is an obligation fundamental to the process of scholarly inquiry." With that said, we also value our relationships with industry. I mean, Louisiana State University is uniquely positioned to work on the challenges facing the energy industry. And we do that by talking to members of industry to find out what the issues are. We are a land-grant institution and part of the reason that the United States set up land grants in the 1860s was to make sure that we had applied research that could be used to solve problems. And that's exactly what we're doing.

So we've conducted two workshops where we bring industry together with our professors to talk about what's going on in the marketplace, what they're seeing, what are the problems where universities are uniquely positioned to be able to solve them and that allows us to tackle them. And that's what has led to projects like Dr. Tsai's being funded. Once we get a proposal for a project, we send these out for third-party independent academic review that's done on a blind basis. We use a firm in Washington DC to do this. It's extensively peer-reviewed and we get the results back from that before selecting projects. So overall, you

Dr. Frank Tsai
There is no significant difference in the southwest Louisiana and southeast Louisiana in terms of geology. The only difference you can see is the Mississippi River. The Mississippi River in the Pleistocene and Holocene create a tremendous sediment deposit along the Mississippi corridors. So that created a very unique deposition in the southeast Louisiana. Other than that, the Southern Louisiana geology pretty much similar.

Brad Ives
Great. Thank you for that. Here's the next one. By surface displacement, do you mean the surface elevation would increase due to injection of CO_2? And then another part of that is what order of magnitude would you expect for the change?

Dr. Frank Tsai
Yeah, that's a very interesting question because normally you inject the CO_2 into the deformation, maybe below 6,000 feet to 8,000 feet. You are going to inject tremendous amount of pressure into the formation. So naturally the pressure will push the ground upwards, create a kind of land uplift. That's the land surface displacement meaning. Yeah. Because of pressure, huge amount of pressure under the ground created by the CO_2 injection. And how much, I don't know at this moment, and I believe this answer can be found in the literature somewhere. Okay. Yeah.

Brad Ives
Great. We've got time for one last question. Will Dr. Tsai's study be published or otherwise available to the public?

Dr. Frank Tsai
Yes. Several groundwater studies I present are already published in two journal articles and the third one is under review right now. And I believe the other co-PIs' results will also be published in the near future. So that will be all shared with the public.

Brad Ives
Great. Thank you. Thank you very much. And we've come to the end of our time. We've got a number of questions that have come in. We'll take a look at these and try and post some answers to the internet. And as I mentioned, we'll be posting a recording of this presentation along with Dr. Tsai's slides to the Institute for Energy Innovation website. So I want to obviously thank Dr. Tsai and his team for all the work that they've don0 (dET Qt.der tht timo)

We look forward to seeing you at a future energy event and if there's anything that the institute can do for you or for any organization that you work with, please don't hesitate to reach out to us.

And in the meantime, just remember the future of energy is here, it's here in Louisiana, it's now, and we're all gonna be working on it. So thank you very much for attending and I hope you have a great rest of your day.