A study on mitigation of carbon dioxide leakage from storage reservoir

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Geological storage of carbon dioxide can be a variable technology for reducing atomospheric emissions of greenhouse gases and have been currently in the spotlight for the important mitigation option for global climate change. Geological storage sites would be chosen after careful characterization studies that would especially focus on the ability and integrity of caprock formations to contain CO2, but unexpected things can and do happen. In general, performing remediation efforts which have been suggested is still speculative.
This study focuses on water injecting method , which is the leakage remediation method to inject water at the formations where leakage is occurring from local areas such as fracture areas or abandoned well. We investigate the remediation effects of the water injection method with a numerical simulation model.
The simulations revealed the effects of water injection method, which are
CO_2 dissolves into injected water
Water injection create an hydraulic barrier by increasing the pressure upstream from the leak
Water injection create an impermeable barrier by water occupying the flow area of CO_2
CO_2 is trapped by the capillary pressure (residual gas trapping)
And the simulation also revealed the effects of water injection method are influenced by parameters, which are
Injection depth
Injecting water at deeper depth achieves more efficiency. In particular, injecting at the closed region of leakage induces the reduction of leakage rate.
Injection time
Injection time from leakage slightly impacts on the effect of remediation. However, we must inject the water still time limit. If we should not inject the water or stop leakage, CO2 plumes reach to the subsurface.
Horizontal distance from leakage point
Horizontal distance between injection point and leakage point greatly impacts on the effect of remediation. Especially, we find out hydraulic barrier and impermeable barrier play part in leakage remediation at the beginning of leakage, and residual gas trapping is more important after stopping the leakage to prevent the seepage from the subsurface.
In case of injecting at more points (horizontal well), the effect of remediating leakage is well enhanced and upstream CO2 flow is fully prevented. We conclude that water injection method is useful for remediating leakage under the condition that we inject water at closed area from leak point.
Assuming that the location of the leak has been established, two remediation approaches have been proposed:
Sealing the leak by drilling a nearby well and injecting foam, time setting gels, or cements ; or using other sealing substances to close the leakage pathway.
Producing the CO2 from the storage reservoir and reinjecting it into a more suitable storage structure.
However, these two approaches can be complicated and time-consuming processes. We suggest water injection

method is so useful because water injection method can contribute to delay seepage and provide time to repair leakage for us.
Our contingency strategy was based on a lot of assumptions because the development of possible approaches for remediating leakage in cap rock remains an important area for future research. However, it is novel trial to create the contingency strategy based on the quantitative analysis and to introduce time concepts into it. We expected that this contingency strategy contribute to create the more effective and finer remediation approaches in the future.