TO FIGHT WITH CONTAMINANTS THROUGH INSIDE!'

A novel tool for more sustainable management of contaminated sites clean-up

Prevention is better than cure! It is essentially important for the environment and even more important for soil and groundwater of which cure is so difficult. It is mainly because cleaning up involves many different sectors and stakeholders with very different viewpoints and aims. As a result, it is too hard to make a proper decision on how to deal with it. The poor decision maker might either fulfil everyone's expectation and be recognized as a hero or fail and be recognized as a zombie! There are decision support tools out there to help, but these are not often used for real problems. Why? Well, you don't want your choice to be made in a miraculous way and you feel no control over it, do you? Firstly, we need to know what we are doing. Secondly, we do not want to be left alone after the main decision with no further guide! But there is hope. Here comes INSIDE: INfluence-based deciSIon guiDE to look inside the decisions that are made to help clean contaminated sites. INSIDE structures the problem and the solution(s) by handling real world interactions among involved factors. This makes a big difference.

You all make a lot of decisions in your everyday life. Basically, in any decision-making problem, you have a *goal* that you want to achieve, and you have some *options* to choose from. Moreover, you have some important *factors* that matters to you and fulfilling them, ideally, guarantees achieving the goal. Say you want to decide how to get to a party. Then, you have some options to select among, option A is to go by bus, option B, by your fantastic car, and option C is to walk all the way. Next, the factors that you would like to base your decision on are probably: time, money, safety, environmentally friendliness, to seem cool, to seem rich, and maybe to seem an on-time gentleman/lady. But, how would you feel if I have a look at you and put your desires into my algorithm and tell you that option C is the best option? A miraculous way, right? You wouldn't even ask me what the option C was! You would just say: "Well, thanks, but… you know, is it really my best option based on the overall importance that I could think of for each of my favourable factors?"

You are right. It does not seem to be a reliable way of helping you. You want more control on your decisions and you want to see how this control affects. You want to see if and how your considered factors are properly recognized. You want to see how prioritizing them can affect your final choice. You want to see consequences of this all the way!

Anyway, the important factors in the party example are surprisingly similar to the ones that decision makers in clean-up projects often have. They think about the economic, environmental and social aspects of their decisions. Then technical issues are added to these three piers of sustainable development aspects. See? Almost always a good decision could be defined as a sustainable one.

Recently, at the division of Water Resources Engineering at Lund University, we introduced a new decision support tool for the clean-up practice at contaminated sites, called INSIDE: INfluence-based deciSIon guiDE. INSIDE simply looks inside the decision-making process, recognizes interactions among involved factors and not only gives us the final choice of clean-up (remediation) method, but also provides the ideal maps of our minds over the situation! This mind map is a two-dimensional guide for further decisions that plots our factors' importance versus their influence on the whole system (like in the figure next page).

Influence is defined as the net effect that each factor has on the other factors. Comparatively, importance is defined as the overall effect that a factor has on the system plus the effect that the system has on the factor.

We have gone through the decision-making process in detail and defined many sub-factors for each of these main factors to make INSIDE as practical as it must be. We used the opinions of 51 international experts in the practice from 12 countries to

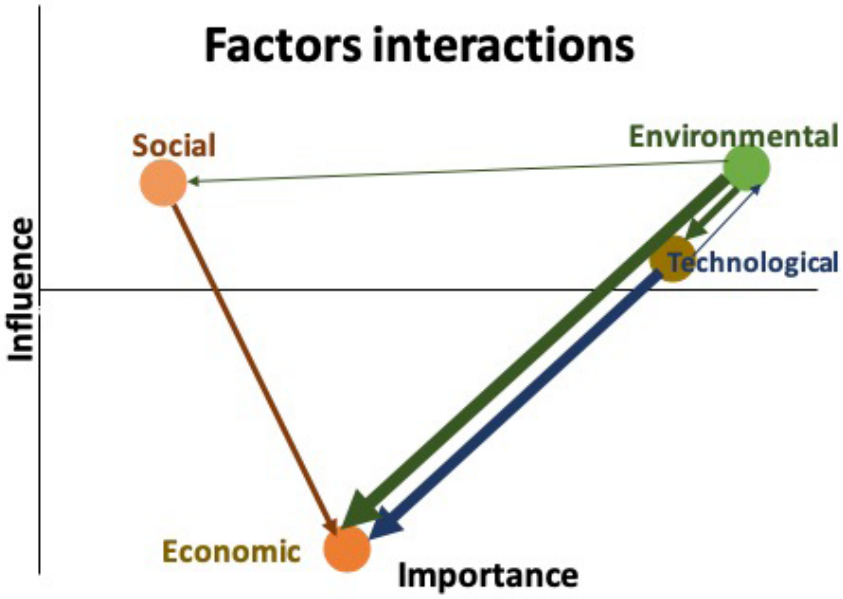

Figure 1. *Factors interaction map. Arrows' directions are from the influencing factors to influenced ones. Arrows' width corresponds to strength of the influence.*

make an ideal mind map as a guide for sustainable decision making in remediation projects. As it is shown in the figure, economic factor is surprisingly not an influential one. Means simply we can't improve other factors and the whole system effectively by spending more money! Social aspect is, on the other hand, highly influential although it has not been paid enough attention to, yet. Detailed map with sub-factors is much more interesting and draws out even more important points. These detailed results are not in the scope of this article and interested readers are encouraged to take a look at the scientific paper about the topic by the author which will be published online soon. This new factors-interaction-based methodology for making decisions is not limited in application only for contaminated sites clean-up. It could be used in any other environmental issue which involves a decision making process for solving a problem.

Now, decision makers have a nice tool that guides them to a more sustainable practice other than giving them the best remediation option alone. By knowing the final remediation option, needed data collection work and blind-sighted trial and error will be significantly less in practice. This means that with the same budget, more sites can be cleaned up.

Anyway, there is a long way to go. As is estimated, we have 3,000,000 potentially contaminated sites waiting for us, just in the green continent!

Mehran Naseri-Rad is a Ph.D. student at Division of Water Resources Engineering, Lund University. He is working on tools for managing contaminated soil and groundwater. But in a broader view, his aim is to make connections between engineering and management for more sustainable solutions in environmental problems. Resulting uninclusive views on contaminant clean-up activities is a threat, he believes, that can lead to significant loss of resources, budget and time. He is introducing System Dynamics simulation to environmental remediation practice as a tool to find the right questions and answering them in remediation projects and environmental problems in general.