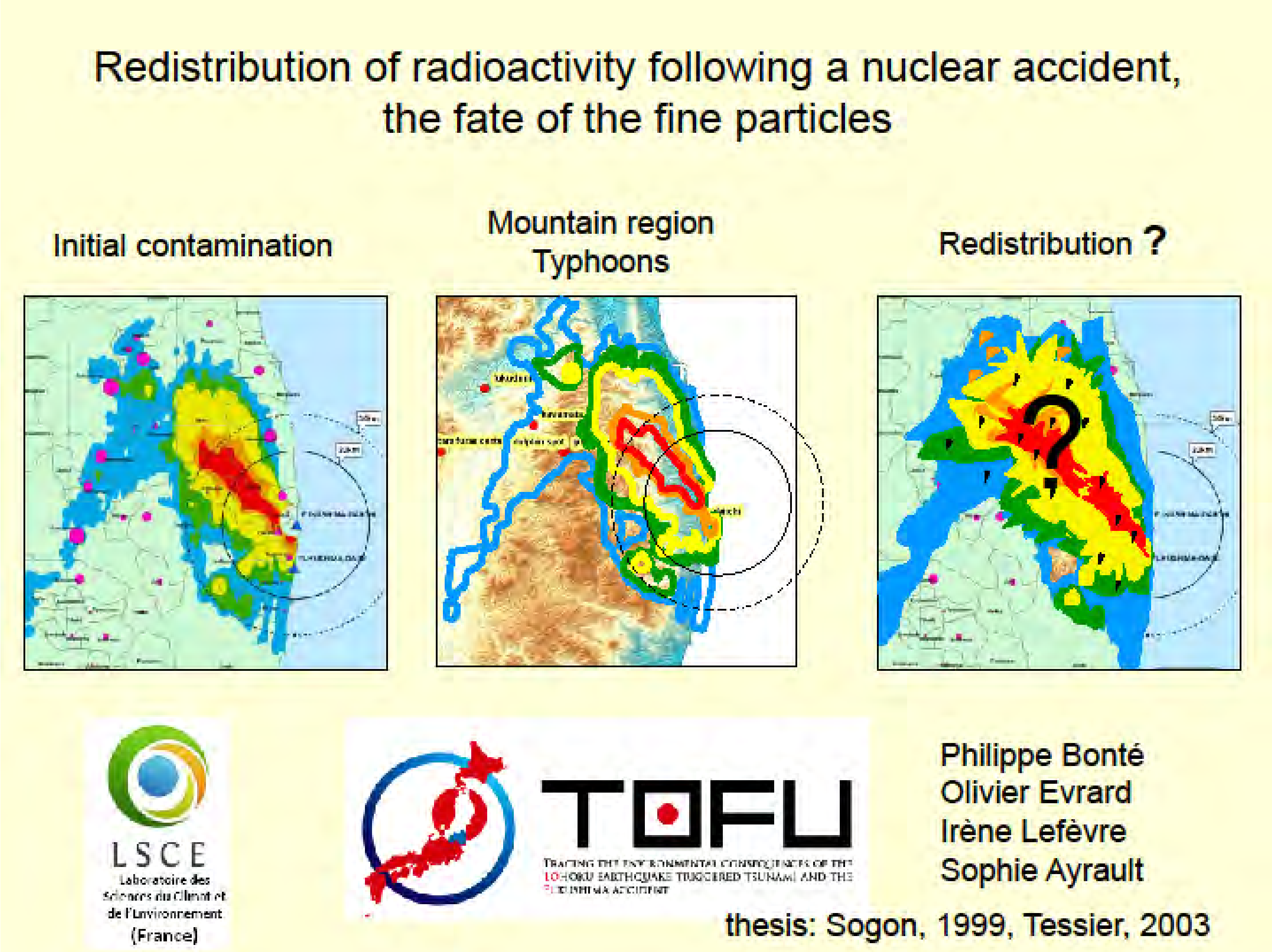

Dr. Philippe Bonté

Thank you very much. Good evening, ladies and gentlemen. I am sorry because my English is very poor. About the Fukushima accident, a problem that is important for me – one of the problems is that this ●.

This map is a representation of the contamination at the beginning just after the accident. But, in fact, the contamination is deposited on the mountain region and it's subjected to typhoon and all the meteorological event. It shows that this map must change. We don't know now exactly where the different contaminant can go.

Our experience

- During the last 20 years we used environmental radioactivity to study soil redistribution and sediment transfert.
- The aim of this presentation is to expose the more interesting results that we have obtained about the fate of fine particles in a catchment
- Following a nuclear accident, the initial cartography of radioactive pollution is not persistant. The fine particle redistribution in the watershed, by rain, flood events (typhoons) or snow melt leads a radioactive redistribution.
- That implies washing of numerous slopes, exportation in the river and the ocean, but also creation of hotpots and contamination on flood plain, often cropped and then radioactive contamination of vegetables a long time after the accident.
- I want expose useful observations that we have done in the 20 last years, and some points to study in the next months and years.

LSCE (France)

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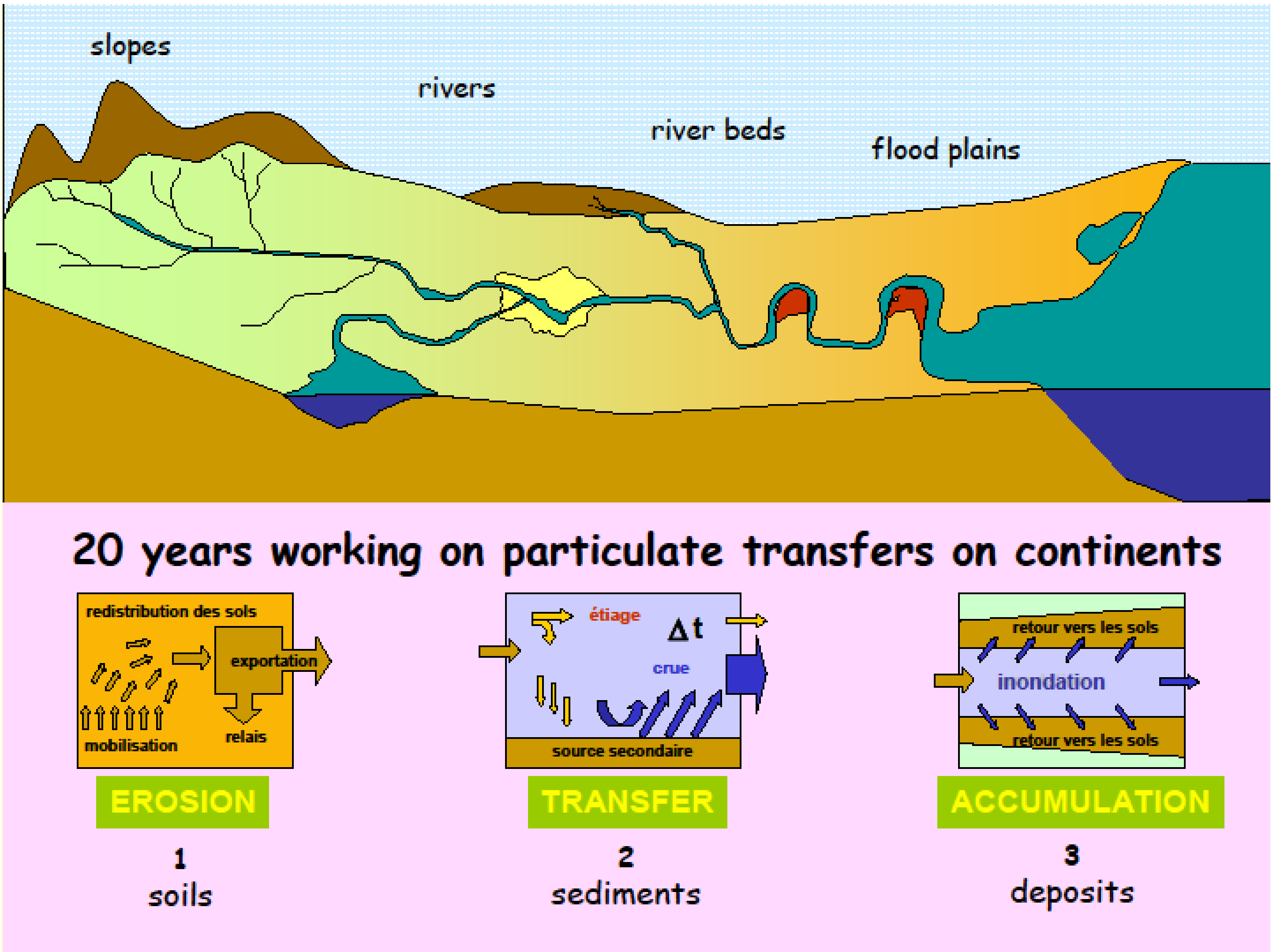
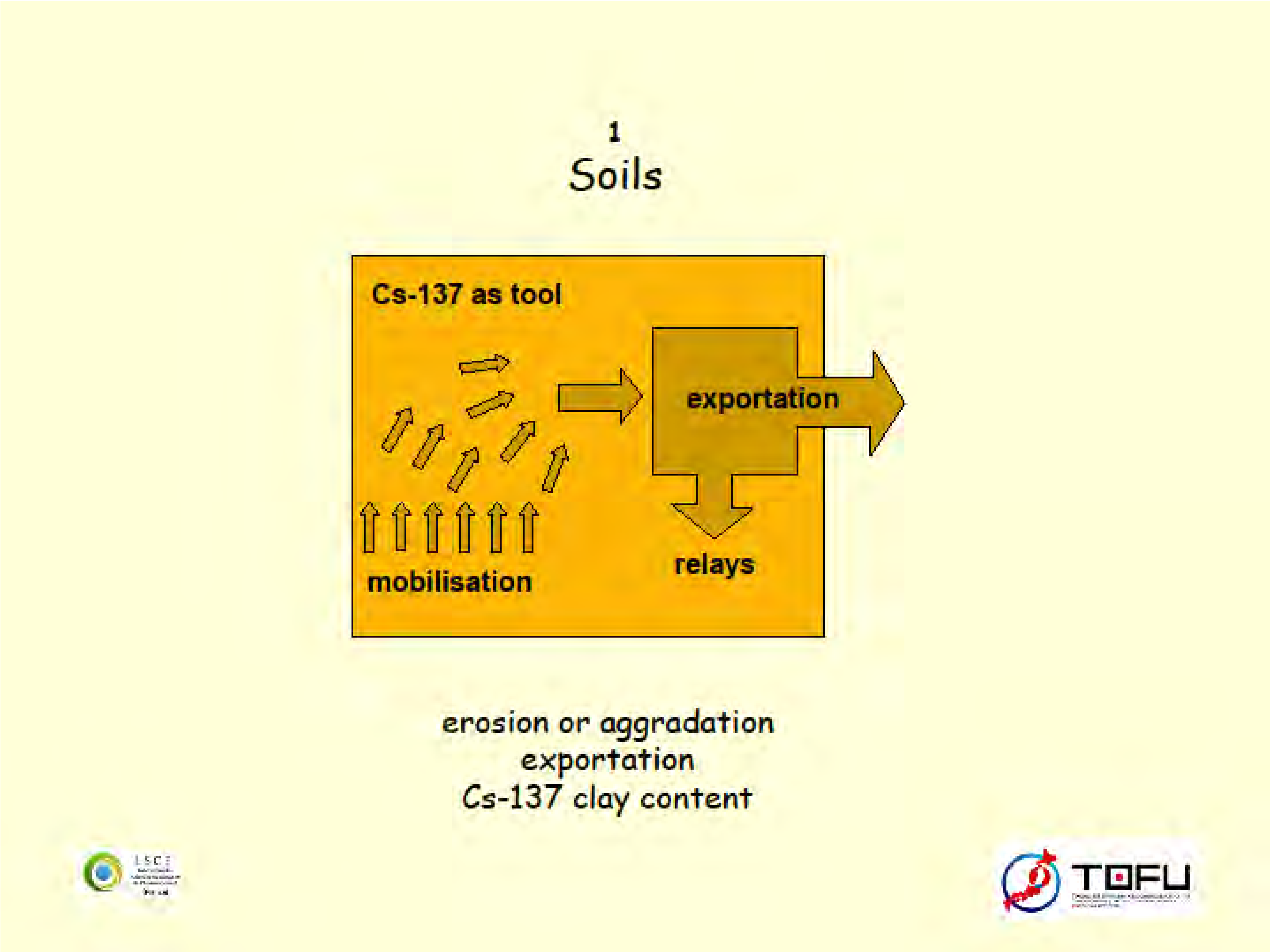
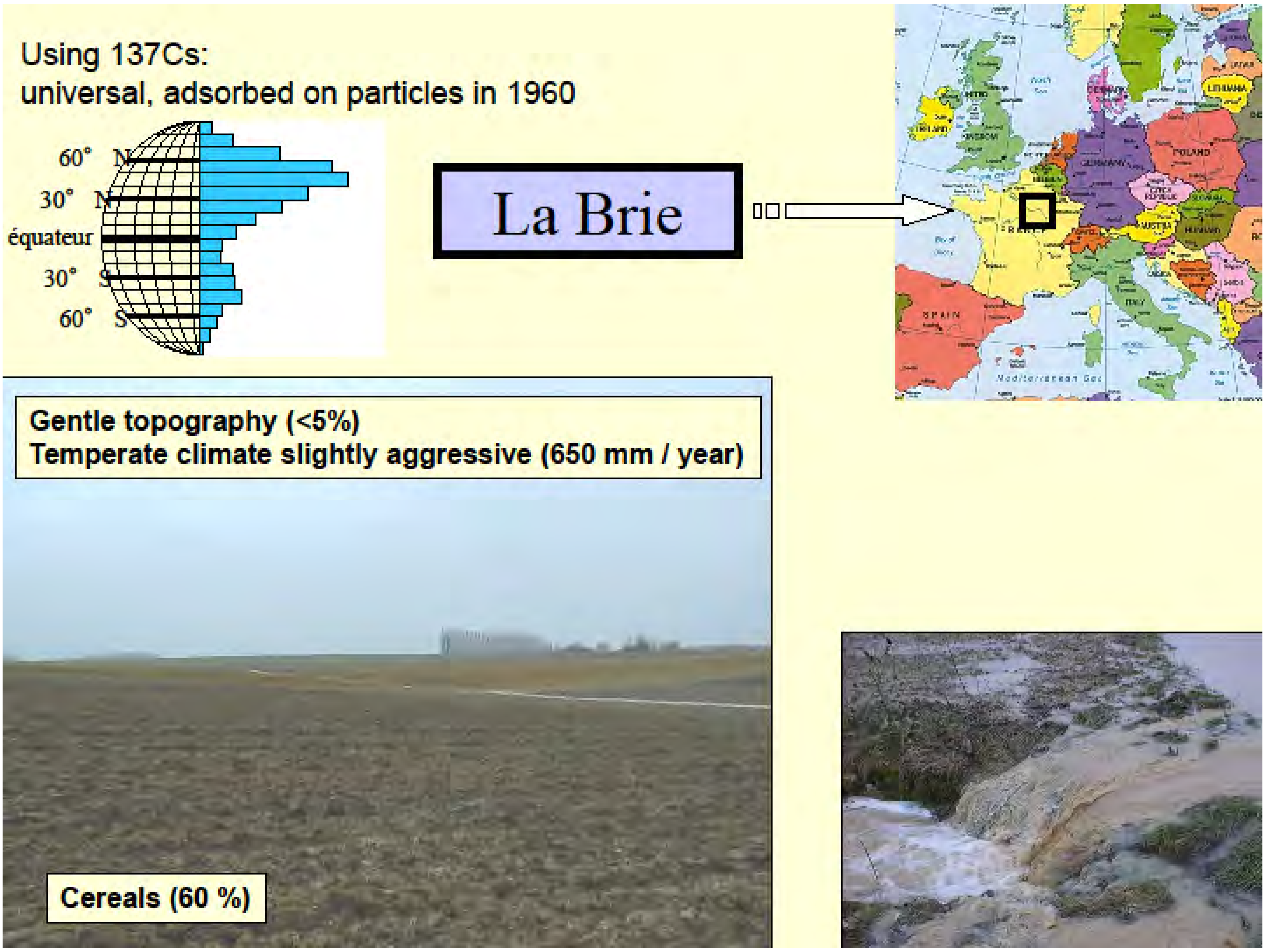
It shows that a part of the contaminant go down in the river and after to the ocean. But a part also can be concentrated in some hotspots very locally. Also, after a large flood coming on maybe cultivated field that was before not contaminated but that can be contaminated in several months or several years. For me it's an important problem. I cannot answer to this problem now, but I try to show you what is useful from our overall experience of about 20 years using environmental radioactivity to trace, to know better the behavior of fine particles in a catchment. Then, the aim of this presentation is to try to present to you what is interesting for this problem from our overall experience.



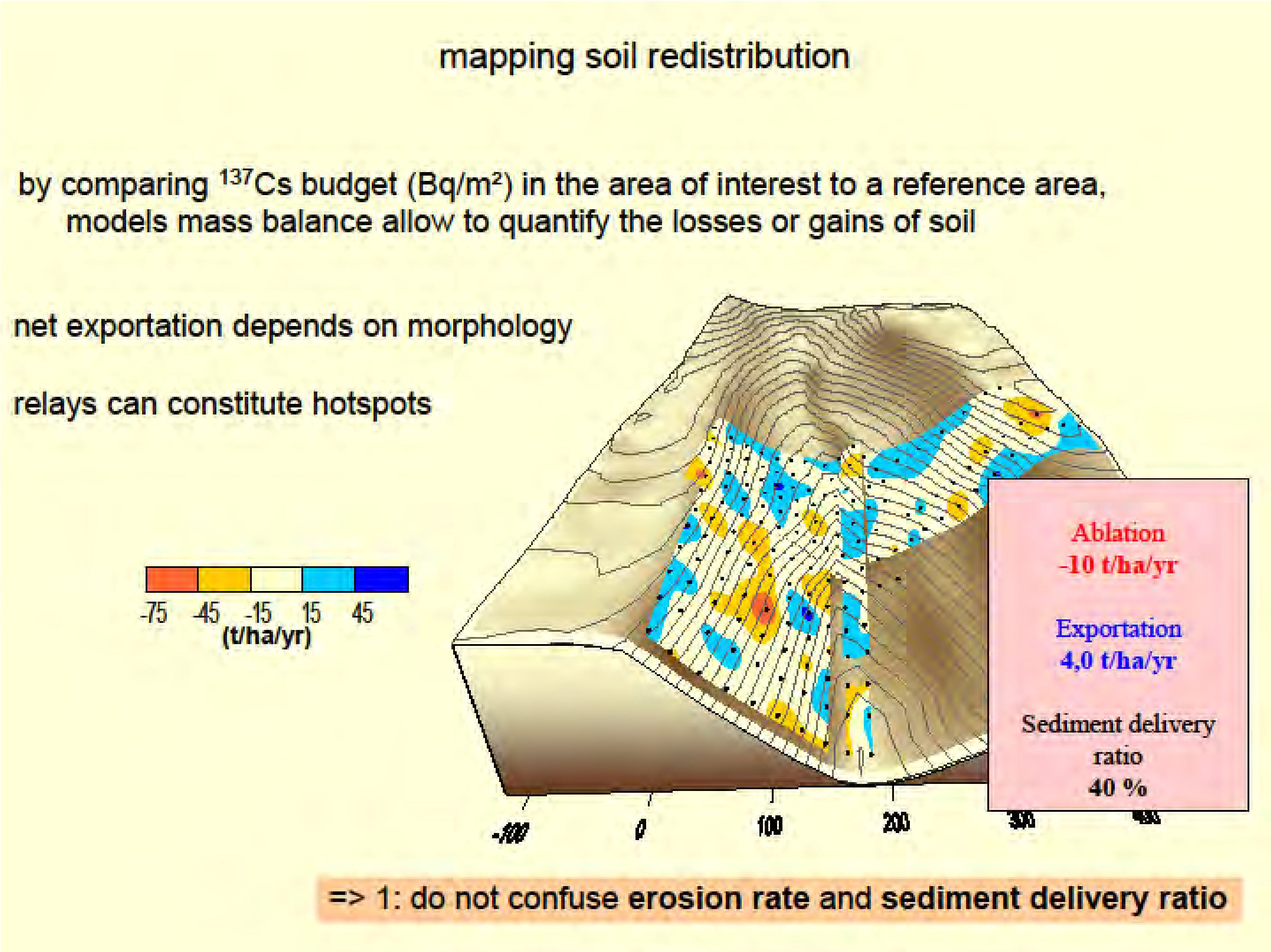
During this about 20 years, we begin to study slopes because some geographer come in the laboratory to ask us how can you measure or determine the quantity of solid arriving in the Seine River. Can you use caesium-137 to measure that? We begin like this, and 3, 4, 5 years the after, we are interested by transfer in the river. The same particles arrive in the river to study how long is the transfer in the river? After, we study also what is the effect of these particles when there are flood, and if we can use it to study the history of the contamination in other element of the Seine River.



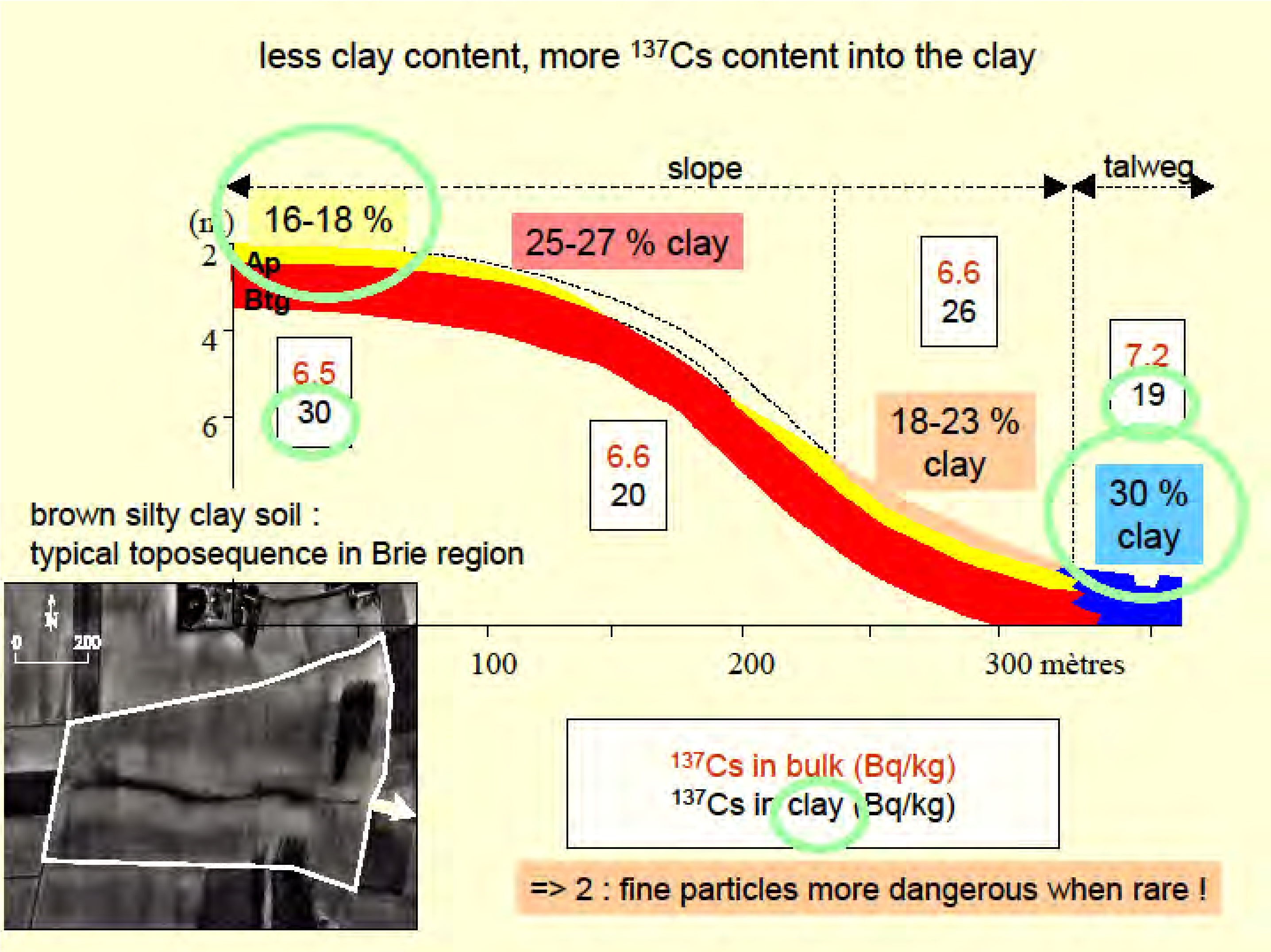
I begin by soil study on the slopes. I want to only give you three points that can be useful for the problem of Fukushima.



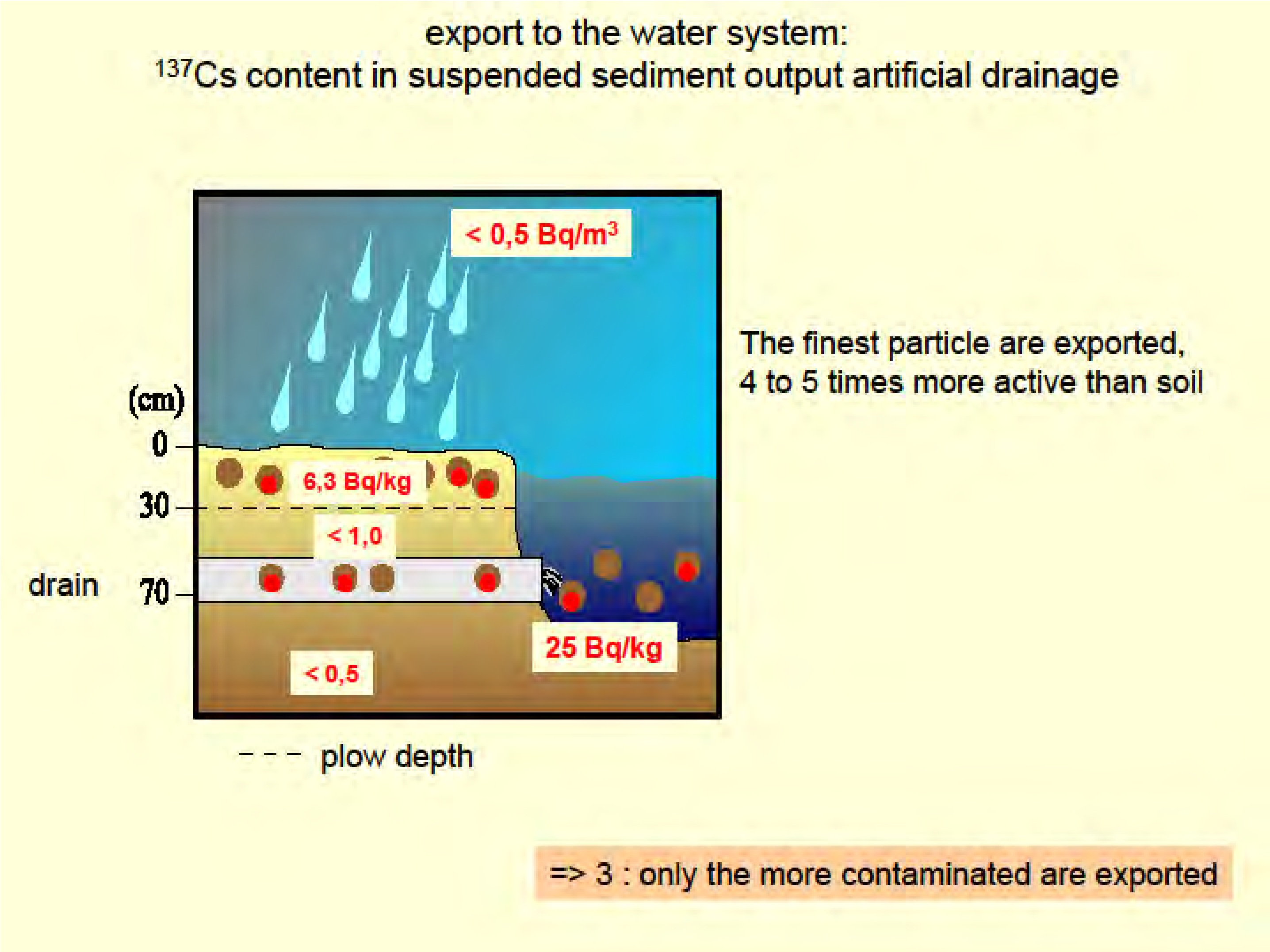
The first one – the main study was in La Brie that is limestone plateau in the France cover up by [Unclear] relatively rich in clay with gentle topography, climate not very aggressive. Sometimes, there are some storms but it's climate very temporary. To map the soil redistribution, then we used caesium-137. This caesium-137, as Olivier showed you, it's different from Cs one of Fukushima or from Chernobyl because it takes several years. It's coming from the bomb fallout, the bomb test during the 60s. It's a long time to go down to the soil. The great ● partition is about homogenous and the scale of the watershed, even if it's a flood watershed, we can assume the great partition of caesium during the 60s is about homogenous.



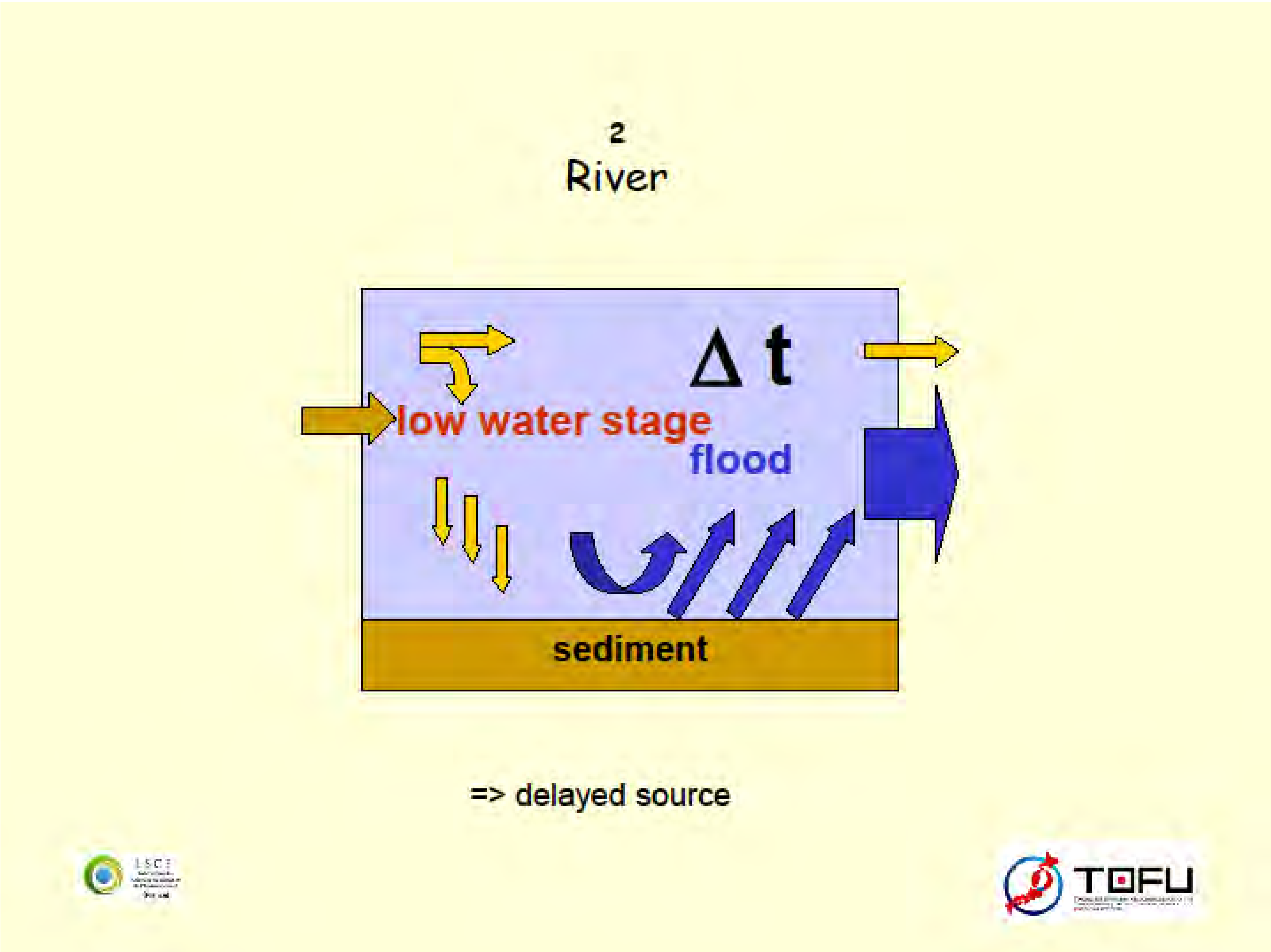
A small problem in place was contamination by Chernobyl that is a shock event and then the contamination is homogenous at a scale of the small catchment. But, we estimate the contribution of Chernobyl in this battlefront is about 25% of the entire caesium. The 0-0 part is coming from the flood [ph]. The principle of this method is compare the inventories of caesium in different parts compared to the reference area. What I want to not show you but exhibit to you is that in a field, there is some erosion area but there are also some accumulation areas. I guess in the case of Fukushima, it's possible that inside the field there are small accumulation continue and give hotspot to look at that you can see now but that will be in several years inside the field.



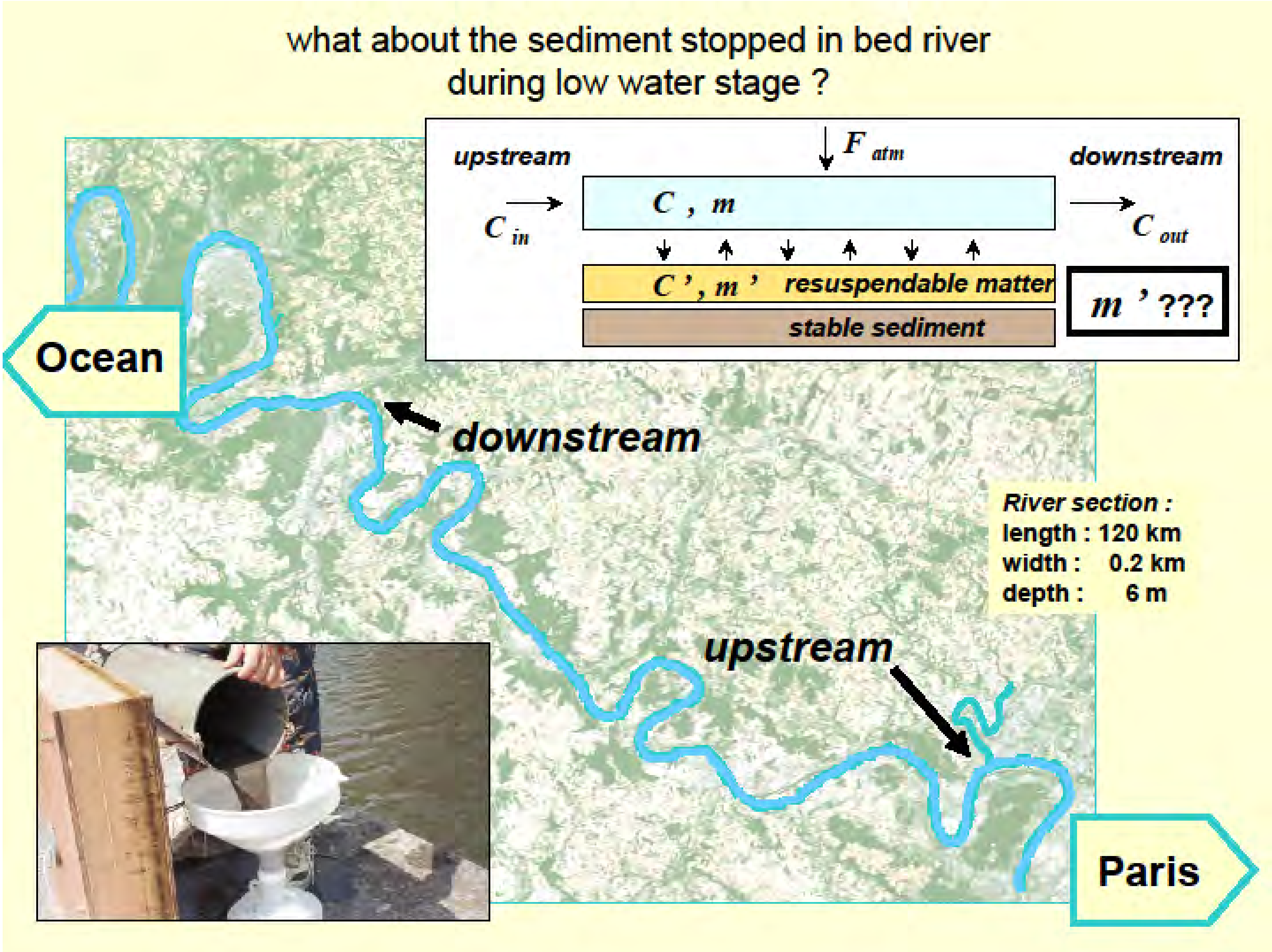
The second point that I want to show is in this soil of Brie region, there are brown silty clay and the toposequence between the interflood ● to the talweg here is characterized by low in clay in the interflood, important clay inside because the superficial layer is the ●. In the bottom of the slope, the clay is accumulated. The particles without grit particles are accumulated, and in the talweg, it's rich in clay. What is important is that here, here, and here the content of caesium is the same about 6.5, 6.6, 6.6, 7.2 Becquerel kilo on this soil, but its clay content is different when you see that clay, you see in the area without much clay is they are very rich in caesium. That means for you is a case of Fukushima, the fine particles are more dangerous when they are rare because the place with low clay contents the consequence is that the clay take all the contamination if the clay are very rich.



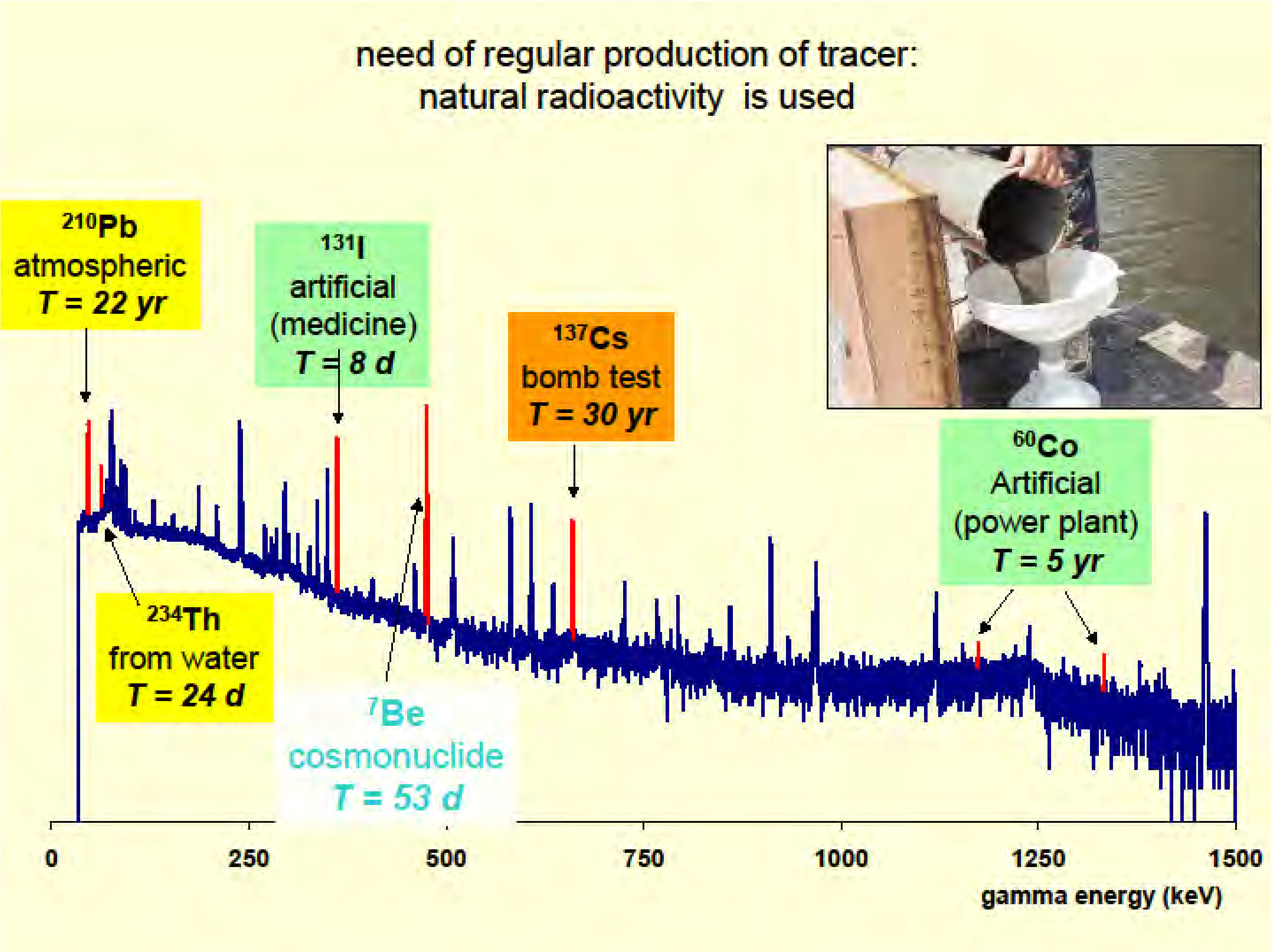
The third point is also a consequence of that. The field that I show you is rich in clay that implies to have not artificial drainage. We measure the particles coming from the drain. In this particle, we measure high activity relatively – high activity of caesium 25 Becquerel kilo about. That means the more contaminated particles that they exported, and it's also a problem for the case of nuclear accident because the bad ones are exported and go in the river.



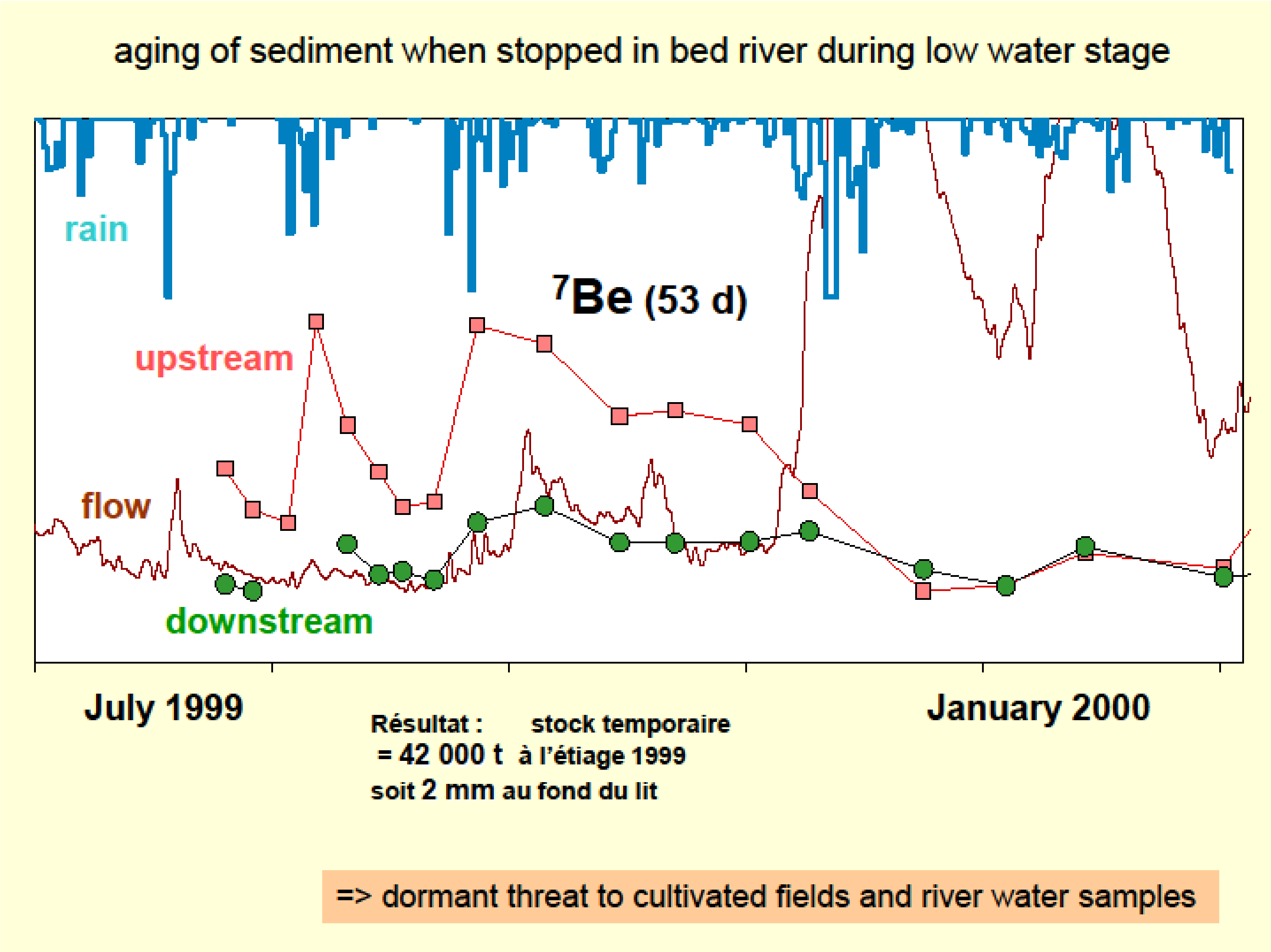
Next step, we study now what is happen in the river, and especially in summer when the flow of the river is low, the fine particle of sediment can be deposited on the bed of the river.



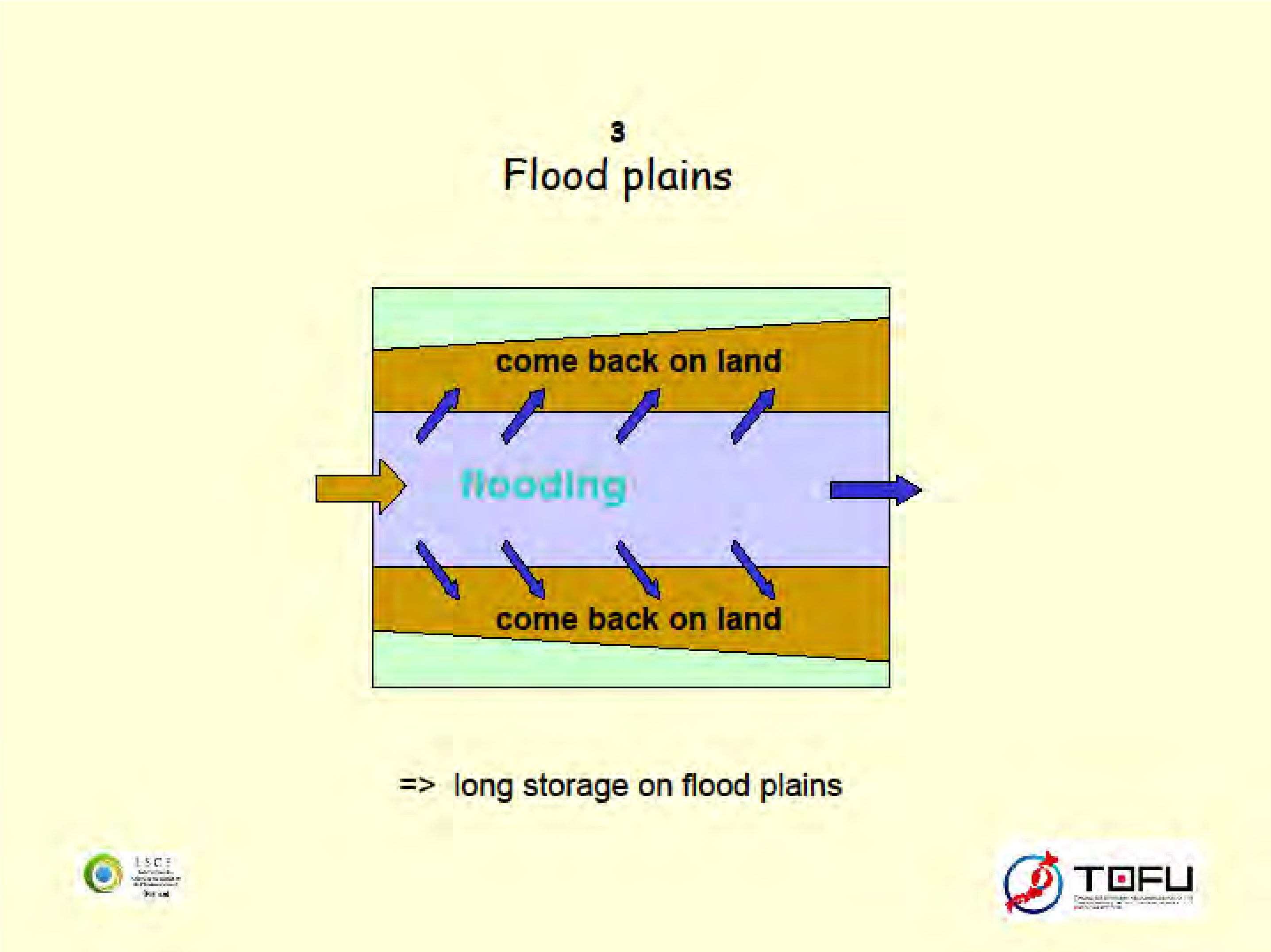
After, with a big flood, they go to river often and they constitute a great quantity of particles in movement in the river. How can we quantify this dangerous source during the summer? For that, we study downstream Paris city channel of the scene without lateral input. It's as 120 kilometers long. We try to measure the aging of the sediment in summer using a tracer that we measure at the upstream as if you will measure downstream. With a simple model stationary model with boxes, we try to measure the mass of resuspendable matter that go away at the first big flow. For that, we cannot use caesium because caesium arrive at one time during 10 years, but now it's not arriving in the Seine River. We must find a tracer that is continuously produced. If you look at gamma spectrum, you can see many lines coming from natural value in the top, uranium, thorium, potassium inside the particles. It's not useful for this problem.



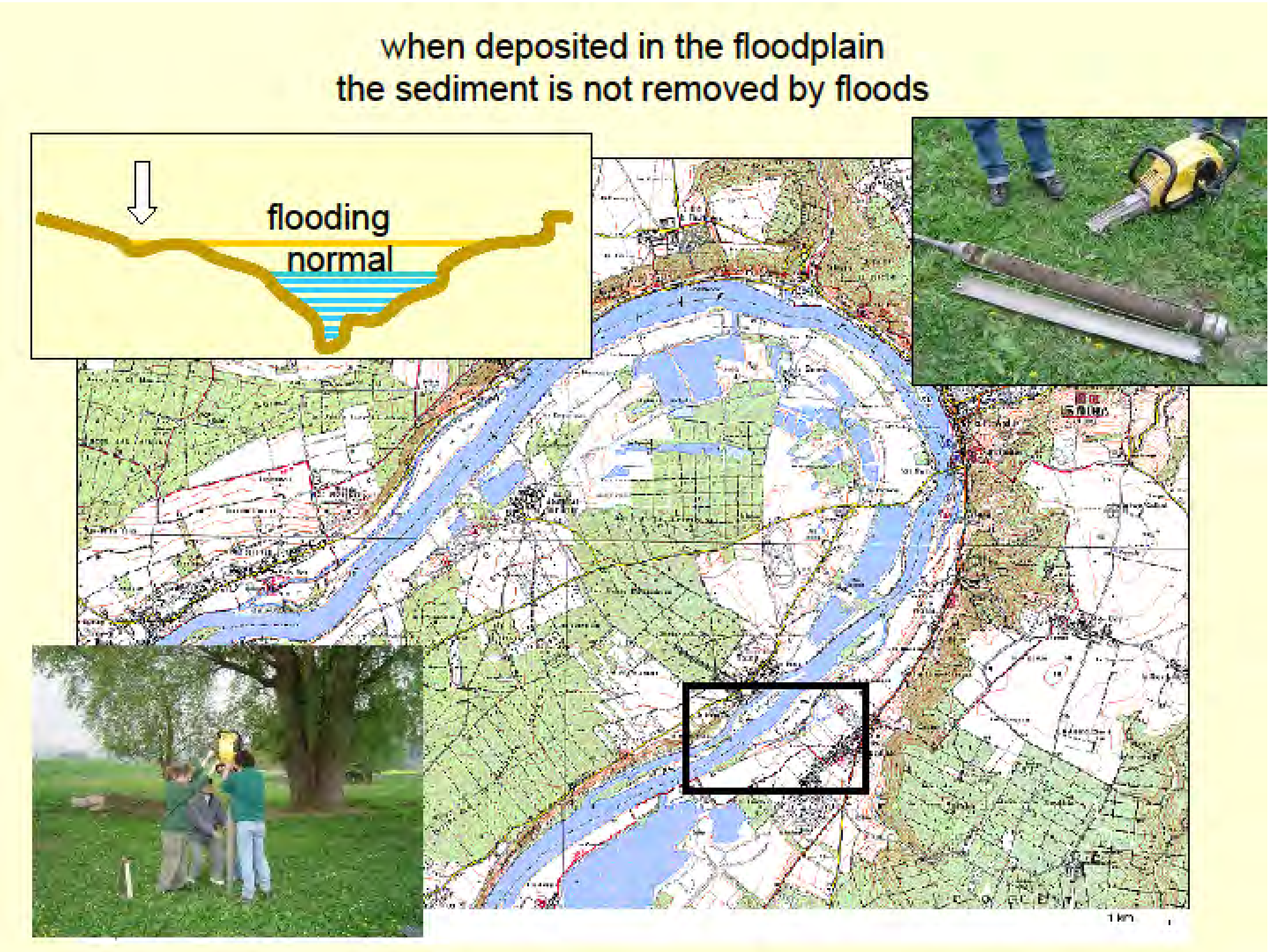
But, you will see also lead-210, it is atmospheric. You will see iodine-131 sometimes coming from medical treatment of some people. You will see caesium. You will see cobalt coming from the power plant upstream phase. But, you see also beryllium-7 that Olivier showed you and thorium-234. Beryllium-7 produced by cosmic rays on the atmosphere. It's arriving on the river by rain. Thorium-234 is the son of uranium dissolved in the water. In the water, uranium dissolve but its son thorium is not soluble then thorium-234 is adsorbed on suspended particles. The half life is 24 days. For beryllium, the half life is 53 days. They are good tracers for this question.



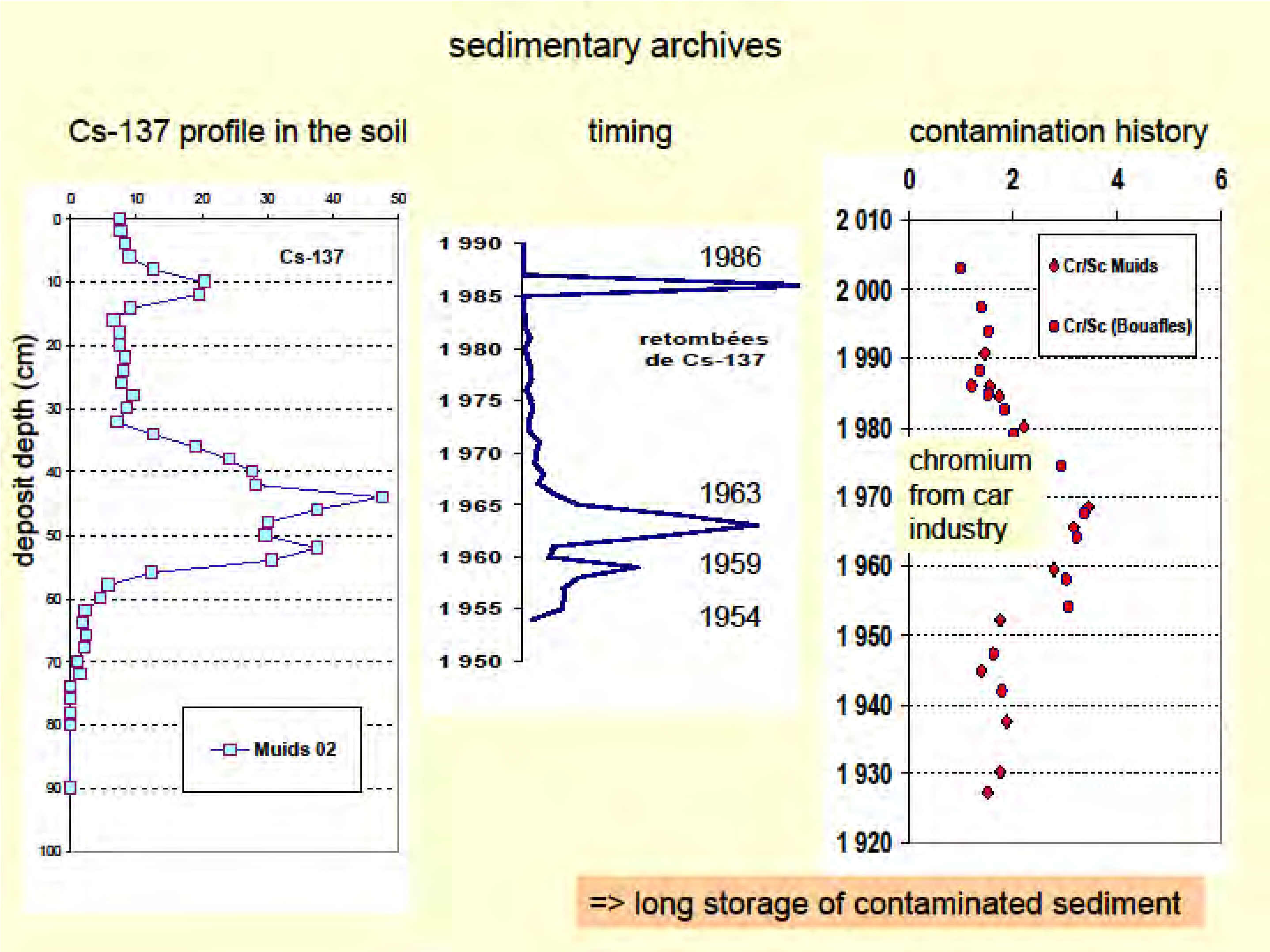
I'll show you the profile of beryllium-7. You can see in summer upstream, higher content, downstream lower content. If you use the model of box that I showed you, you find when the first flow – here is the flow of the river, here is the rain – you find the quantity of sediment deposit in the bed river during the summer. What is the lesson useful is that there is a dormant threat, is you have a big quantity of contaminated sediment that you don't see during the summer, is that it's sleeping on the bed river, and with the first flow, this quantity is going with the river and can contaminate downstream. If you can measure beryllium-7 or measure thorium-234, you find about the same result. It's possible to quantify this quantity.



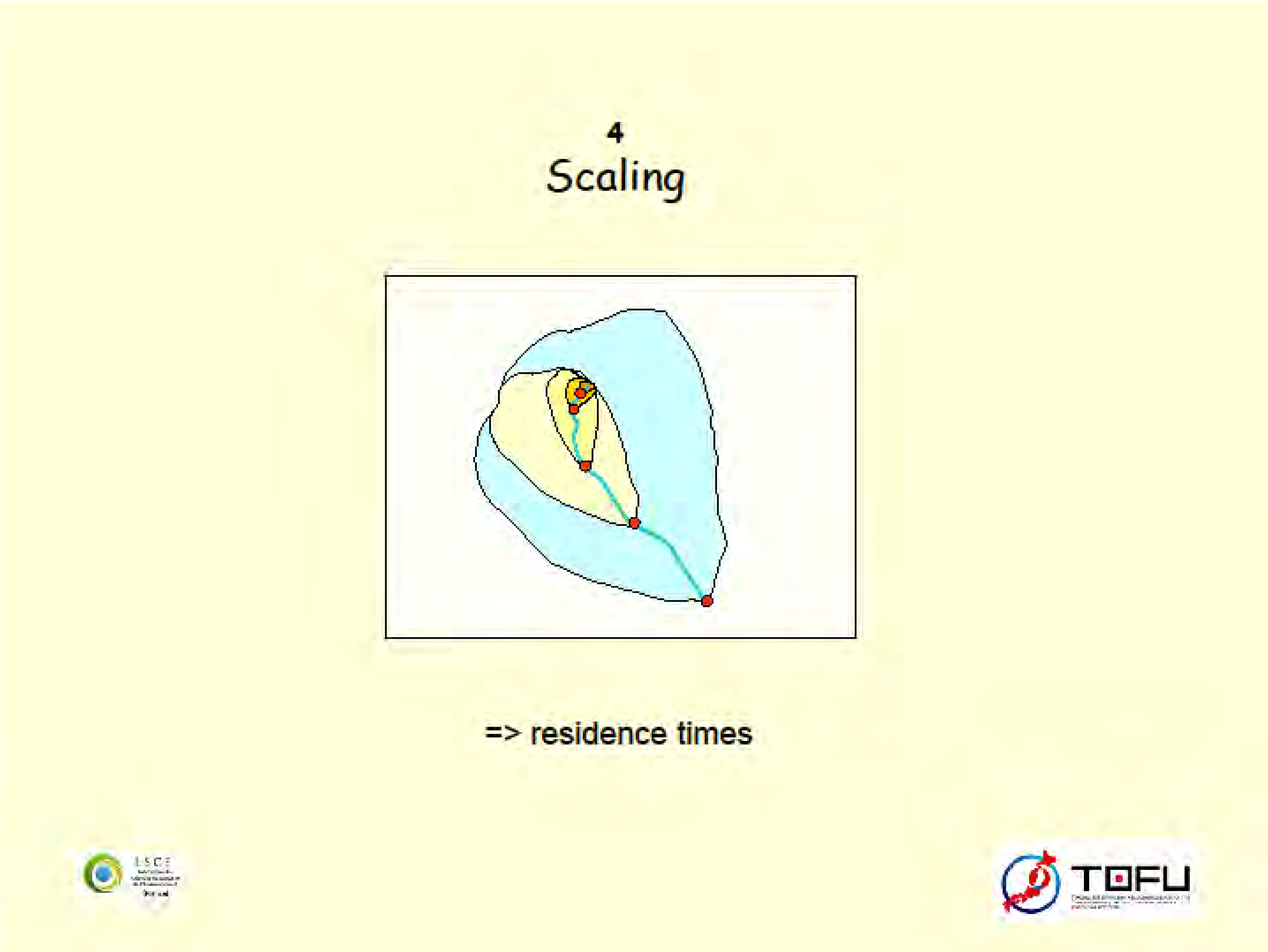
Next step, what is about the floodplain when the major bed of the river is inundated?



For that, it was a problem for us to find a sediment core with good sedimentation to measure trace sediment or contaminant on the sediment to study the history of the contamination of the Seine River. It was practically impossible to find a good sedimentation in the river. To find a good sedimentation, we go outside the normal river on the flooding plain. In this case, we can take the core on the ●, no underwater.

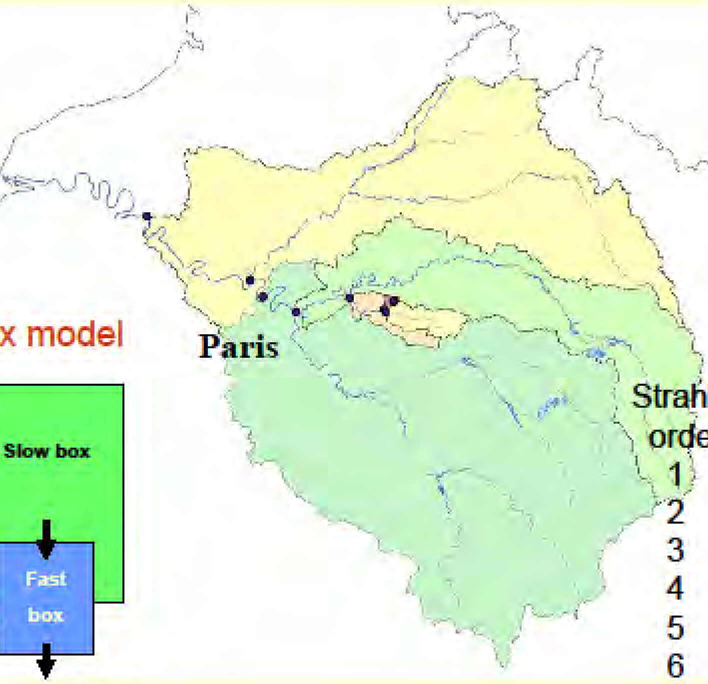


We find a good sedimentation that is the caesium profile in the depth of the core. You get one peak, another peak, another small peak. You can identify this peak to the Chernobyl fallout, the big measure peak of fallout, the second peak of fallout at the beginning of bomb fallout. After, with that you have the timing of the sediment in the core and if you, for example, put the chromium content of the core, you can see the history of the contamination of chromium in the cell. It's not important for here, but what is important, that is one century of sediment saved on the land and coming from the river. That means if you have contaminated sediment, they go on the – they comeback on the field, it can stay long time.

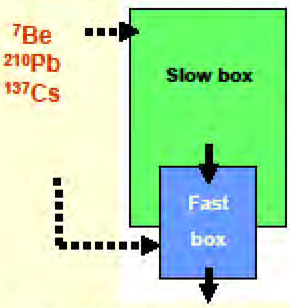


Next step, we want also to study with the model that Olivier showed you, the residence times of particles in succession of watershed nesting, small watershed and a bigger one and bigger, bigger, bigger and compare the residence scale versus the size of the watershed.

inventories in nested watersheds



a two box model



need three isotopes to works

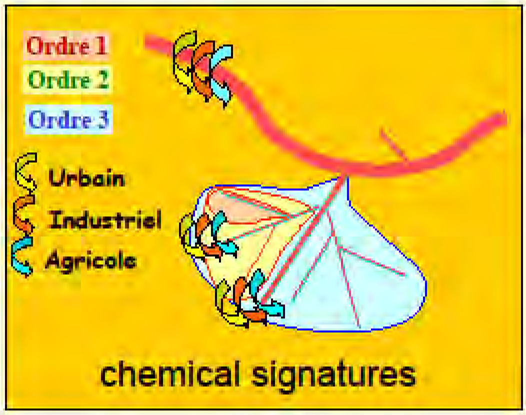
Strahler order	fast box (days)	slow box (years)	exportation (t / km² / yr)
1	290	6400	59
2	250	14000	59
3	220	9000	39
4	280	9000	40
5	440	23000	40
6	390	29000	20
7	390	55000	17
7	485	53000	7

=> soil / sediment residence times are depending of the catchment size

Using this model with two boxes, we need three isotopes to work because the equation have many unknown, but with three isotopes, we can resolve. What we find? We find that in fast box, the residence times are about the same, about 1 year, each scale. But in the slow box is Strahler order of the results that means this 60,000 square kilometer for this catchment, the residence time is very long compared with the small watershed. That means in the case of Fukushima, you can have exportation from the small watershed, you can measure that, but it's not for that that the contaminated sediment go until the ocean. It stays in the large area and it's a big problem because the large region will be contaminated after – it's evident that we arrive to demonstrate that with radioactive underwater resistance.

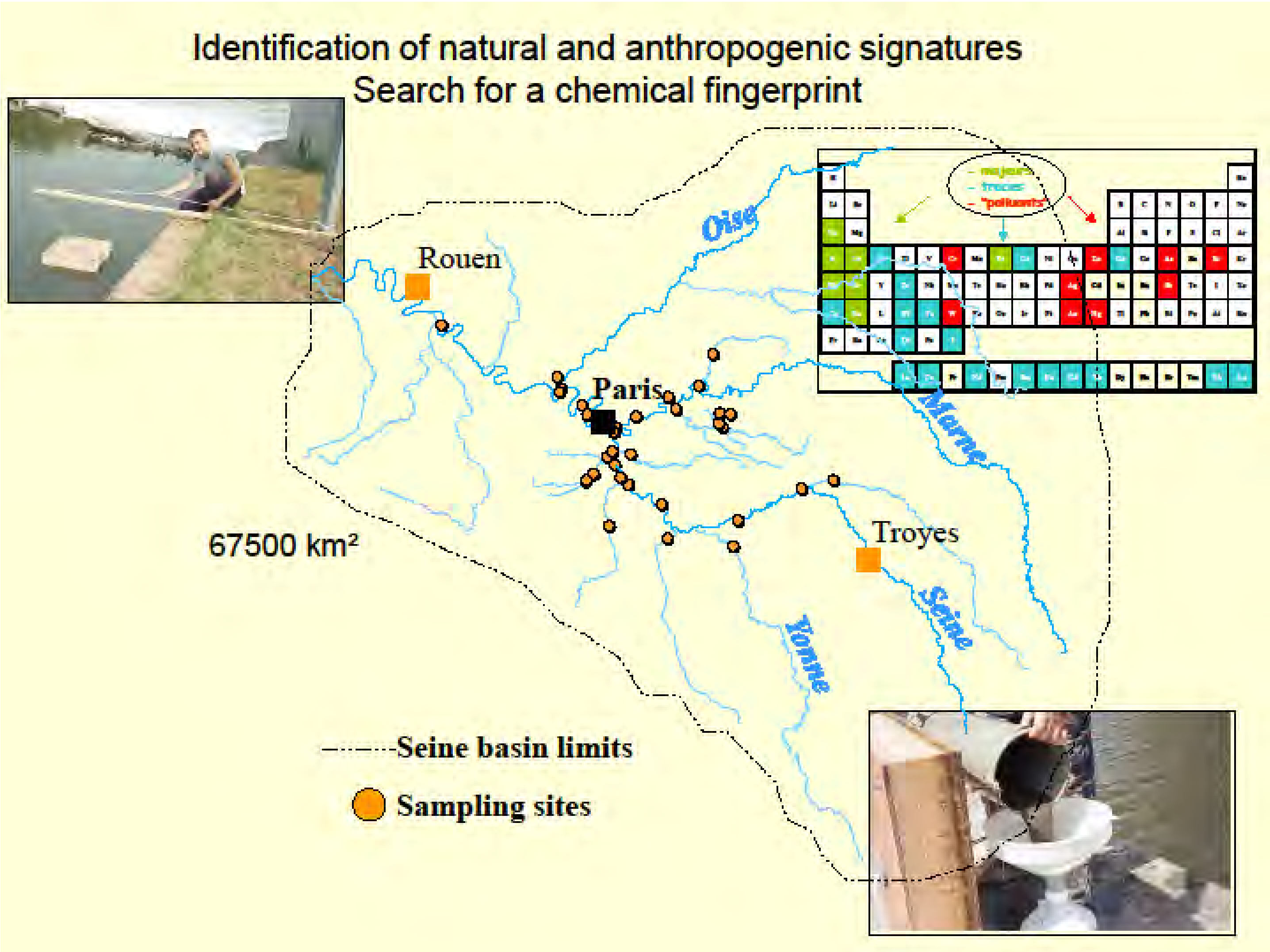
5

Sources

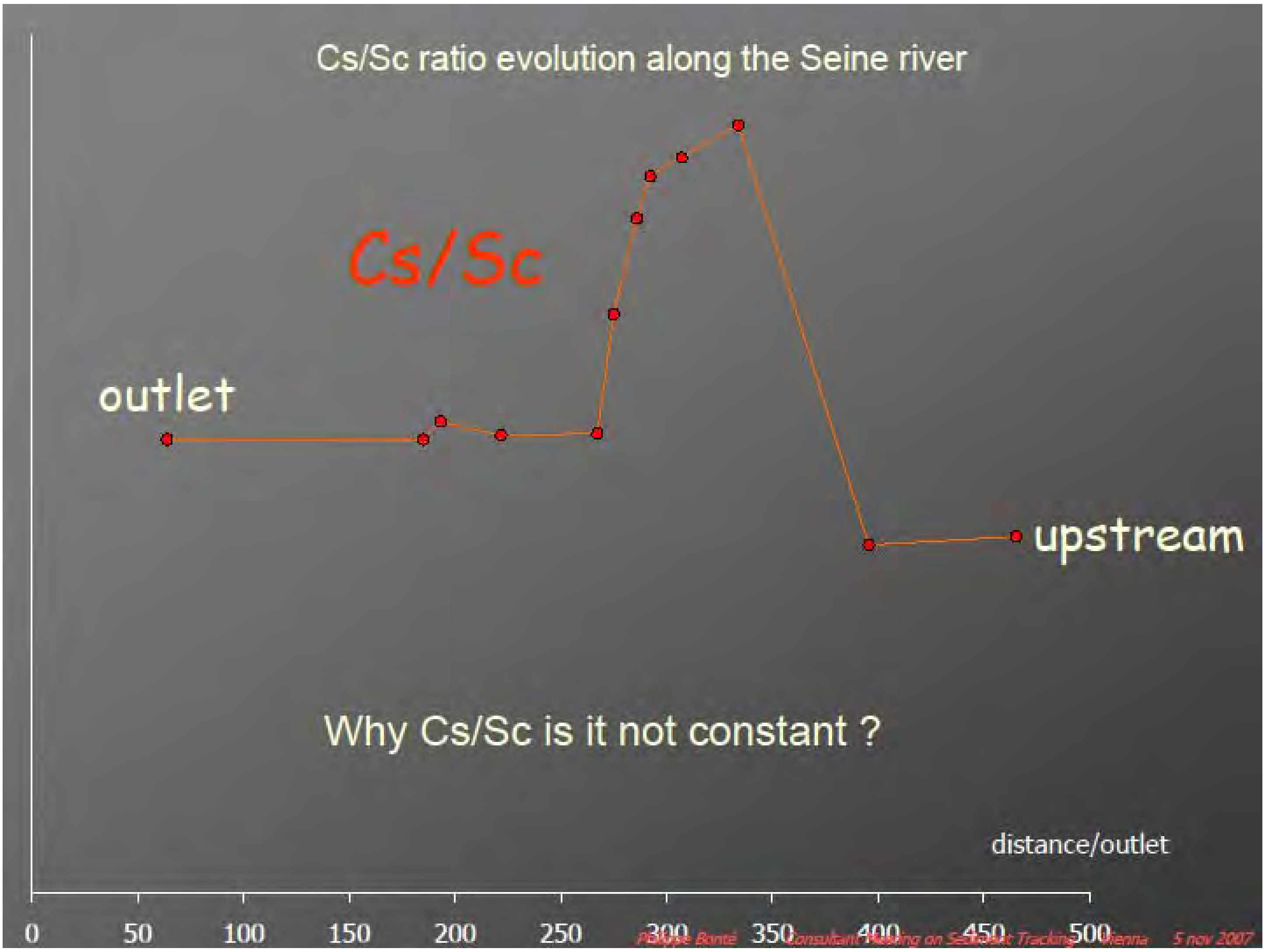


=> discriminating the sources

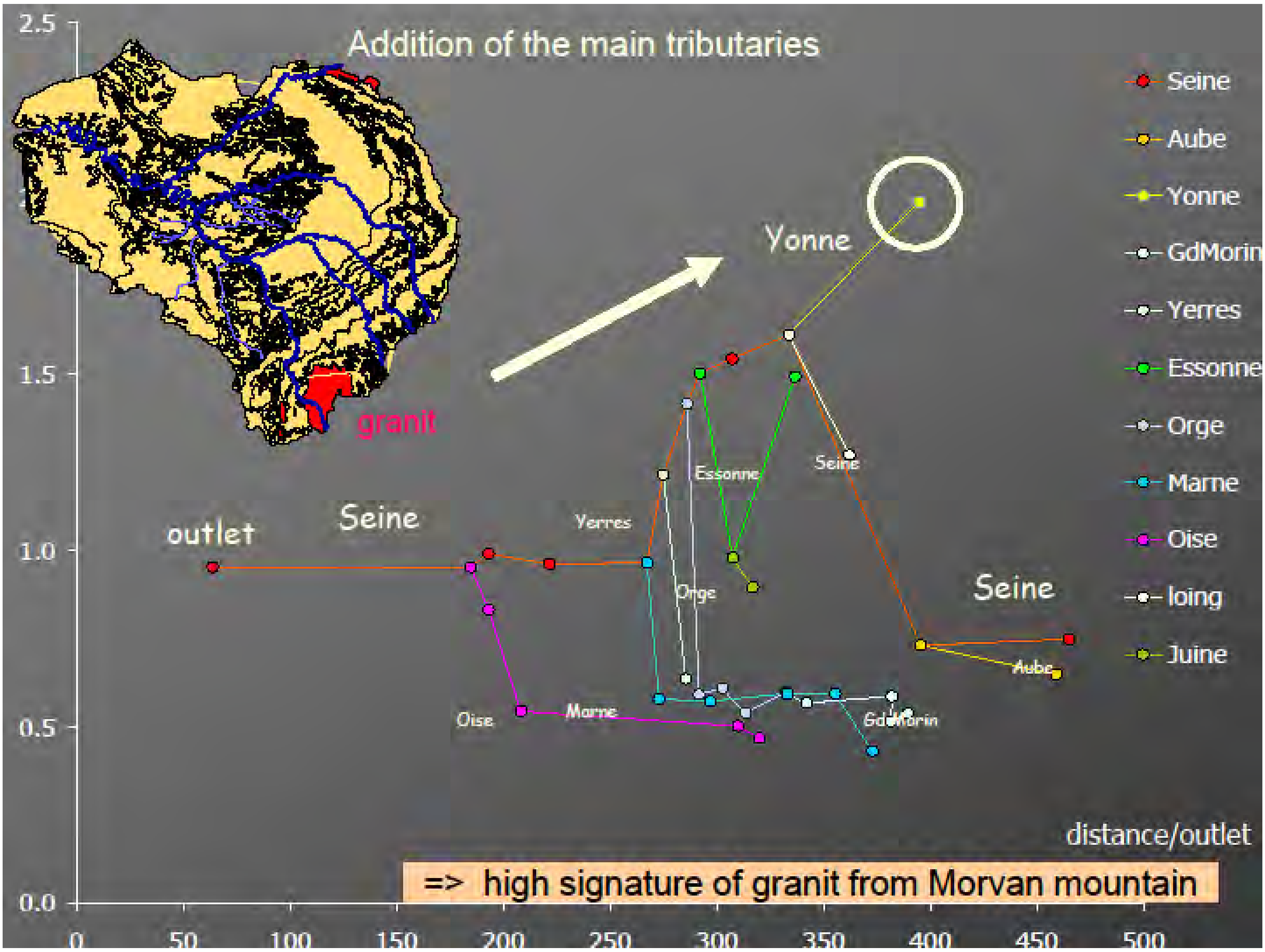
Next and the last step is identify the sources.



Olivier showed you what he found in the Mexico or in the Alps that we begin by measuring 30 sites in the different river of the Seine Basin, the maximum of elements that we can measure, to try to find the signature of the different sources.



It was difficult in the Seine River because this basin is essentially sedimentary and relatively homogenous. But, we remark surprising results concerning the element caesium low radioactive, that is chemical element caesium normalized to scandium because scandium allow ● to normalize the fine fraction. It's the mean to eliminate the problem of ●.



If we look at the ratio of caesium versus scandium from upstream of the Seine River to the outlet, to the downstream, we see here about 0.6, the ratio is – it's about 0.6. Here, it's about 0.91 and a peak here at 1.6. For me, it was surprising because for me caesium is an element normally correlated with scandium or lithophilic element. But, in fact, there is an explanation in the Seine River that is the profile for the Seine River, but if you look other plants coming from Yonne, Seine River rises. But Yonne is a river coming from here, with a very elevated ratio here, and also =the Essonne= River have some affluent exchanges.

But, in fact, the Yonne River and some other affluent coming from this part of the basin change completely the ratio of caesium versus scandium because they come from granit massive with a signature of very high in caesium and high signature of granit from Morvan Mountain. What is maybe useful for the study area by the group of Professor Onda is this part, I believe, it seems this part is granitic, this part is more work, and maybe it can be useful to discriminate hereafter in the Abukuma River or other downstream sites. If the particles are coming from – maybe caesium is sufficient to those different between here and here, but it can be useful to discriminate the origin of the particles.

Summary

SOILS	erosion rate # sediment delivery ratio fine particles: more dangerous when rare only the more contaminated are exported
RIVER	dormant threat to cultivated fields and river water use
FLOOD PLAINS	long storage of contaminated sediment
SCALING	residence times depending of the catchment size
SIGNATURES	possibility for distinguish granit sources

In summary, several points that seems maybe it’s to say the same thing, whatever.

My main concern :

With regard to the contamination of agricultural products, we can fear a natural worsening of the consequences of the disaster by typhoons and other causes of flooding.

My main concern in this is the problem of Fukushima is the typhoon and the consequence of transport by river on the – come back on their own of the contaminated sediment. Maybe, here we have some possibility just to ● radionuclide.

I present you Irène Lefèvre that is in our group and I hope she is coming for the next week. Here is the link to stop inundation upstream of the Morvan River tributaries of Seine. Thank you very much.

[Male]
I'd like to ask you about the use of scandium. Where that scandium comes? From industry or naturally…?

Dr. Philippe Bonté
No, no. They are completely natural. Scandium or caesium?

[Male]
Scandium.

Dr. Philippe Bonté
They both are completely natural. Why we use scandium is because I've done by neutron activation analysis and the content of scandium in ● sediment is about 10 ppm. But with neutron activation analysis, it's the most easy to measure even if it is very small in quantity but with neutron activation, it's very easy to measure and is always correlated with fine fractions with clay. It is complete enough…

[Male]
Okay, interesting.

[Male]
Thank you very much for… Any more questions? ● fine particle in that river and ● region could you explain that particular parameter of fine particles.

Dr. Philippe Bonté
The particle sizes? They are the clear fractions. The number is less than 2 microns, but in fact you can assimilate to less than 10 micron. In fact, I've shown we do very specific separation. Not us, but in the laboratory ● in France. They separate 0.1 micron and up to 2 microns, but I don't know separate 0.1 micron. For that they need to use – raising [ph] to disassociate very fine particles. But for the question, is clay normally 2 micron? No, for instance, it depends. For the suspended sediment in the Seine River, it's less than 50 micron, it's corrected by scandium.

[Male]
Same thing. ● River also about 50 micron ●.

Dr. Philippe Bonté
Yeah.

[Male]
Thank you.　I just wanted to ask you about when you implicate your method to the Japanese ● River on the tributary of the ● River that the Seine River and the Japanese rivers are quite different in terms of the like silts.　My question is what would be the most difficult part when you apply the method to the Japanese rivers…?

Dr. Philippe Bonté
What will be the…?

[Male]
What will be the most difficult part?

Dr. Philippe Bonté
For which problem?

[Male]
If you apply the…

Dr. Philippe Bonté
For contamination or to measure…?

[Male]
Year, contamination.

Dr. Philippe Bonté
For me, it's a problem for the people that cultivate vegetables on the plain and if you have a big inundation, now maybe there is no high contamination, but maybe in several months or several years, great quantity of sediment contaminated can arrive.　I don't know if it's possible to anticipate this event and build some small protection to avoid the sediment to go in the – because there are very flat area.　Maybe, it's not difficult to do a dam to protect for the future cultivated field.　They are actually no highly contaminated but maybe possibly in several years.

Male1
Okay.　Thank you very much.

[Japanese]