

# ***Modelling runoff and erosion in an ungauged cultivated catchment of Western Russia strongly contaminated by Chernobyl fallout***



**Franco-Russian Project**  
**CNRS / RFBR**



Olivier Evrard, Catherine Ottlé,  
Vladimir Belyaev, Maxim Markelov, Nadia  
Ivanova, Irène Lefèvre, Philippe Bonté



**TOFU**

TRAJECTOIRE ENVIRONNEMENTALE CONSEQUENCES OF THE  
Tchernobyl FALLOUT IN THE ENVIRONMENT AND THE  
FUTURE OF THE AREA

**Tsukuba University**  
**16 November 2011**



**LSCE**  
Laboratoire des  
Sciences du Climat et  
de l'Environnement  
(France)



**Laboratory on Soil Erosion  
and Fluvial Processes**  
**Lomonosov Moscow State  
University**  
(Russia)



## **Dr. Olivier Evrard**

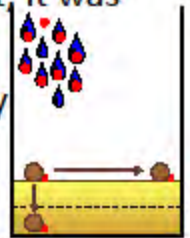
I think I will use your microphone in this. Thank you. Good evening, everyone. I will talk about the work we did with Russian colleagues from the University of Moscow. We worked actually on modeling runoff and erosion in one of the areas of Russia that were strongly contaminated by Chernobyl Accident fallout. Professor Onda asked me also to give an introduction of Chernobyl fallout and the consequences of this radioactive fallout in the environment.

- I am not a nuclear engineer nor a Chernobyl accident specialist...
- I was 4 years old when the Chernobyl accident occurred...
- Polemic interpretations of authority management of the accident and its consequences

*Playing in the  
familial garden in  
1986...*



- When we worked in an area of Russia contaminated by Chernobyl fallout, it was not to investigate the contamination issue
- We wanted instead to use the radioactive contaminants (and particularly caesium-137) to **trace soil particles** and sediment in catchments

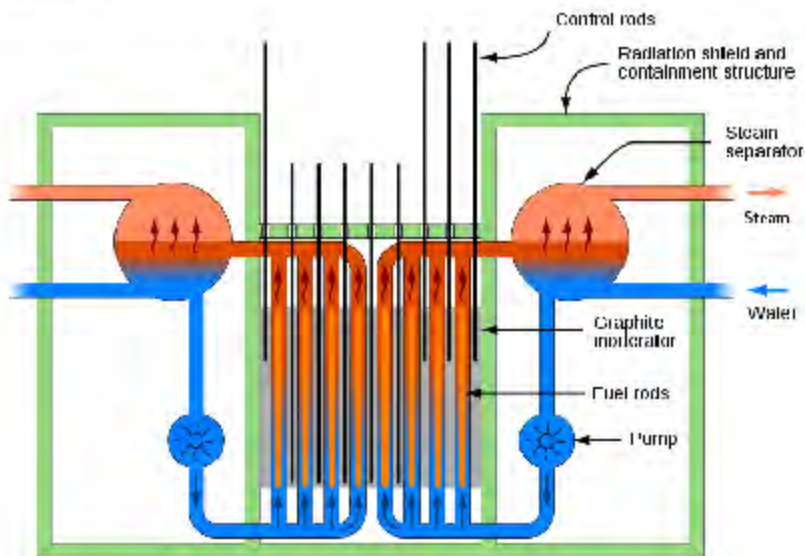


Just I wanted to start with some remarks as a foreword. First is that I am not a nuclear engineer nor a Chernobyl accident specialist. I want just to give you a few elements, a brief overview of what happened there. It's also associated, perhaps, somehow with what I have heard about Chernobyl since I was a child. In fact, when the Chernobyl clouds flew over Belgium, where I was when I was a child, fortunately the weather was nice. As you can see on these pictures, my mom found back in the family albums, I was playing with my small brother in the garden.

In fact, there was a lot of polemics about Chernobyl because there was no precaution measurement taken when the clouds flew over most of Europe. In fact, when we worked in the area of Russia contaminated by Chernobyl fallout, our objective wasn't to work on the contamination itself but to use the radioactive fallout as a tracer of particles and sediments because with the fallout, most of it goes to the ground with rainfall and then absorbs onto particles and we use this caesium as a tracer of the particles.



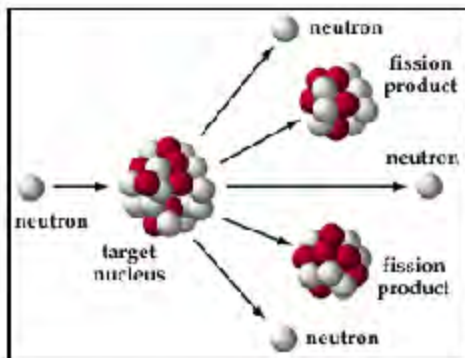
- The Chernobyl nuclear power plant: RBMK (*High Power Channel-type Reactor*) reactors



- Failures during a « safety test » started on 25 April 1986
- Core explosions that led to massive radionuclide emissions into the atmosphere
- Several fires were triggered and lasted ~ 10 days

As I said, I'm not a nuclear engineer nor a specialist, but that is to show you where Chernobyl is in Eastern Europe, at the border between Belarus, Ukraine, and Russia. It's what they call RBMK reactor, so a very old style reactor with only one water circuit. In fact, several failures occurred during safety tests that power plant engineers started on the 25th of April in 1986. It led to several core explosions that led to massive radioactive fallouts and emissions into the atmosphere. After those explosions, there were several fires triggered that lasted at least 10 days. The local firemen weren't equipped to extinguish the fire and they had many problems to stop it and they had to put a ● and several substances to try to keep it under control.

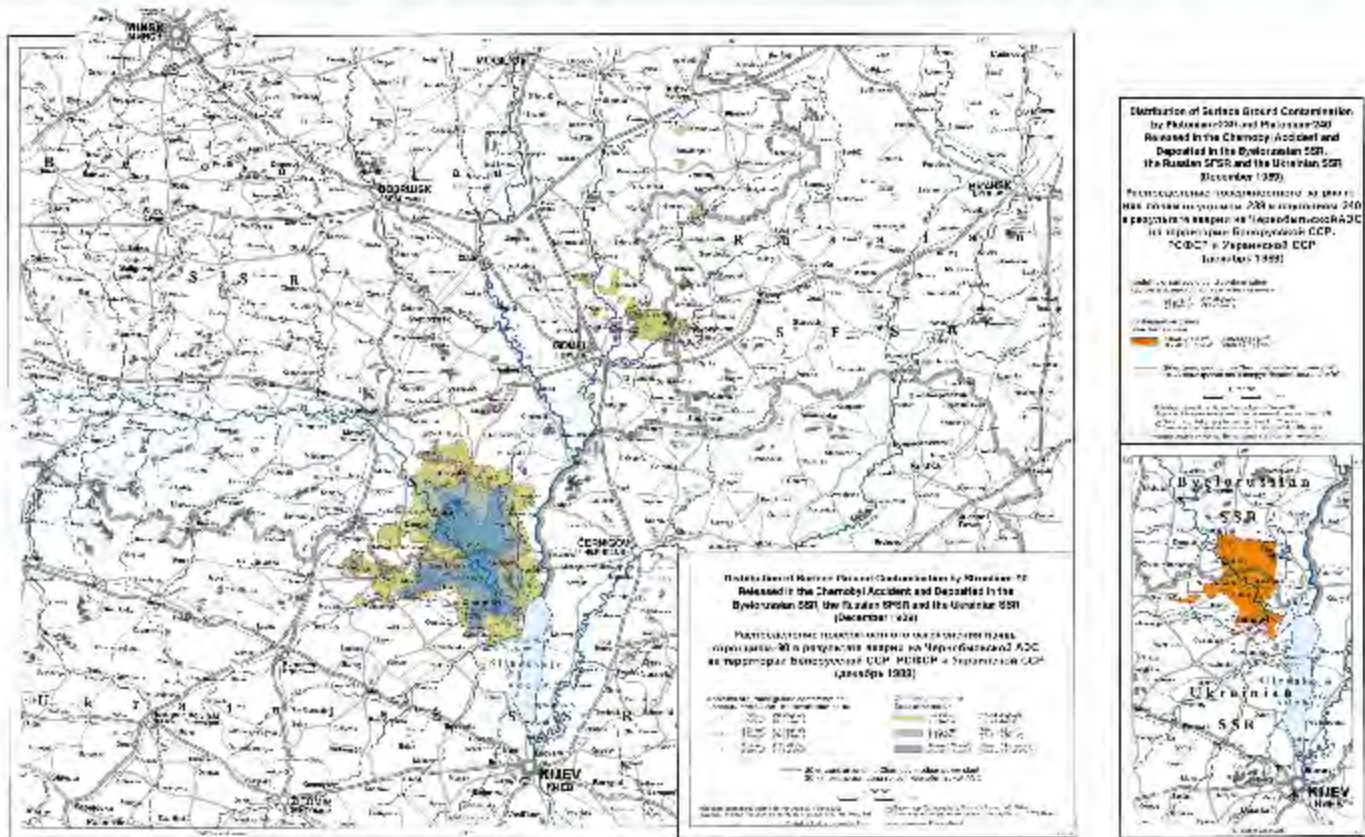
- An important remark regarding Chernobyl nuclear power plant:
  - Nuclear fuel was used >> it is changed every 3 years
  - At the time of accident, nuclear fuel had to be changed!
  - Consequence: fuel contained many radioactive fission products
- **Nuclear fission products** are produced during uranium splitting



- Krypton-85 (gas)
- Strontium-90 (bêta emitter, calcium mimic)
- Iodine-131 (thyroid)
- Caesium-134
- Caesium-137
- ...

An important remark I wanted to make regarding Chernobyl accident was that the nuclear fuel they used in the power plant was actually old and at the point to be changed when the accident occurred. That means that at the time of the accident, the nuclear fuel contains many radioactive fission products. That's what is shown in the graph below, so you have your target nucleus, uranium, and then when it's hit by neutrons, there're fission products resulting from this reaction and all other neutrons emitted that can hit other target nucleus. All the fission products that are resulting from this are numerous. It's a bit complicated and have gas components just like krypton-85, you have strontium-90, you have iodine, different radioisotopes of caesium, so it's a bit complicated. At this time, there were many of those products in the fuel and it's made the situation a bit complicated.

### Map of strontium-90 and plutonium-239 fallout in the Chernobyl region



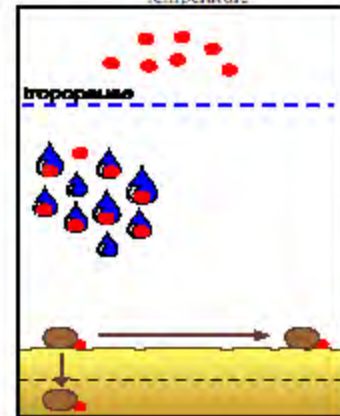
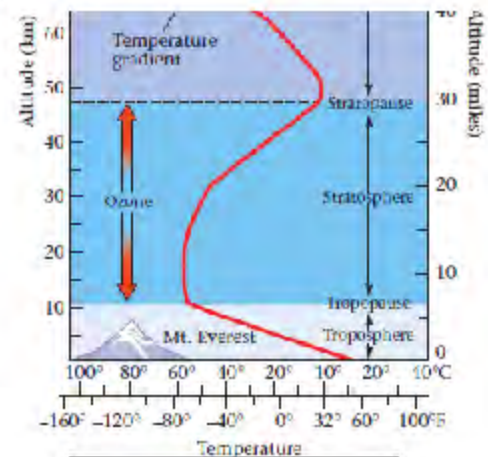
Source: IAEA website

You can find most of the data we have on this accident are related to the caesium-137 emissions. But if it's not clear, if you are at the back of the room, but you can find, for example, the IAEA website, you can find information and maps, for example, in this case of strontium-90 and plutonium-239 fallout presenting from the Chernobyl accident. In fact, the Chernobyl ● is fear and they match strontium-90 concentrations around the power plant and on this smaller map, they mapped the area where they found plutonium. You can find few information that's not so easy to find data related to other fission products. Most of them are related to the caesium fallout.



- Different types of radionuclide inputs into the atmosphere:

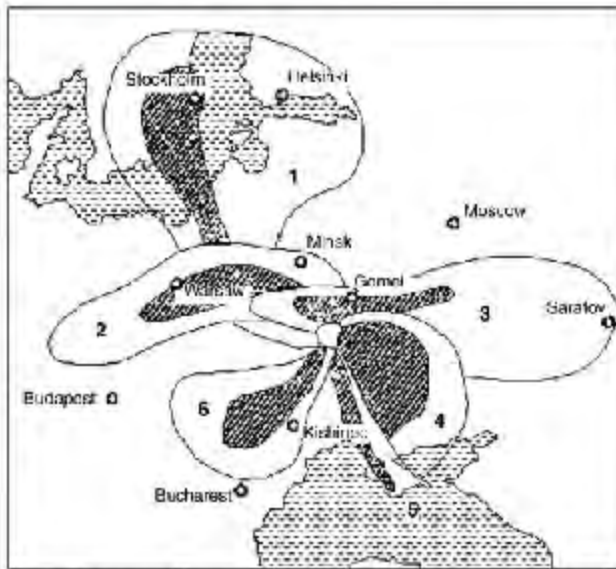
- Bombs (8 – 30 km altitude)
- Chernobyl (1.5 – 10 km altitude)
- Fukushima (2–3 km altitude)
- Radionuclide dispersion was therefore very different
  - more homogeneous in case of bombs;
  - driven by rainfall (snowfall) after Chernobyl and Fukushima accidents
- Polemics regarding weather forecasts on TV



Another remark was that the different radionuclide inputs that were introduced into the atmosphere originate from three main sources in Europe. The first one is the one associated with the bomb test and fallout started from 8 to 30 kilometers altitude, so quite high. At this altitude, you can have just like homogenization of fallout. Then, you can find it back in an homogenous way all across Europe because this fallout was observed during the long periods from a high altitude, and so you can say that rainfall was homogenous during this period and so that this fallout is homogenous across Europe.

Then, you have the Chernobyl fallout that came from a lower altitude, maximum 10 kilometers. Fukushima was even lower from 2 or 3 kilometers altitude according to what I found. The radionuclide dispersion was very different for those different types of radionuclide inputs. It was more homogenous in the case of the bombs and really strongly driven by rainfall or snowfall after Chernobyl and Fukushima accidents. As it is driven by rainfall, there were many polemics, mainly in the case of Chernobyl fallout, regarding the orientation of the weather forecast that was given on TV. In France, for example, there was 'so Chernobyl is fear' and there was a big polemics because people told that the radioactive cloud was stopped at the German border and that it didn't cross the border and didn't affected France. There were many polemics regarding it and it's not easy to find relevant information on this fallout for all the different countries.

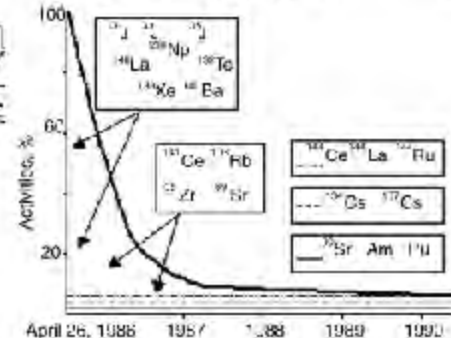
- Several contamination plumes were blown out from the power plant



**Figure 1.4.** Six stages of formation of radioactive gaseous aerosol emissions from Chisnobytl from April 26 to May 4, 1986: (1) April 26, 0 hours (Greenwich time); (2) April 27, 0 hours; (3) April 27, 12:00 hours; (4) April 29, 0 hours; (5) May 2, 0 hours; (6) May 4, 12:00 hours (Barzytalo, 1991). Shading indicates the main areas of the radionuclide fallout.



**Figure 1.**  
early May 10



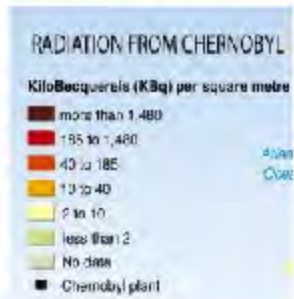
**Figure 1.17.** Dynamics of radioisotope structure of Chernobyl's contamination, percentage of total activity [Yablokov, 2002, from Sokolov and Krivolutsky, 1998].

Source: Yablokov et al. (2010)

In fact, there were fires at the Chernobyl power plant and there were several plumes with radioactive contaminants that were emitted during the 5 to 10 days during which fires were very important from the power plants. You can see on this map that was reconstructed by Byelorussian scientist that it flew over another European countries, just like Sweden and Finland. Then, you have the second plume towards Poland, another one towards Russia, and then additional plumes towards the south. If you look at the path that was followed by the Western European clouds, it was quite complicated and you will find maximum fallout in the regions where there was rainfall.

- Two major contamination plumes were blown out:
  - a western plume towards western Europe
  - an eastern plume towards Russia

Most contamination maps deal with  $^{137}\text{Cs}$



Gomel region  
(Belarus)

Plavsk hotspot (Russia)

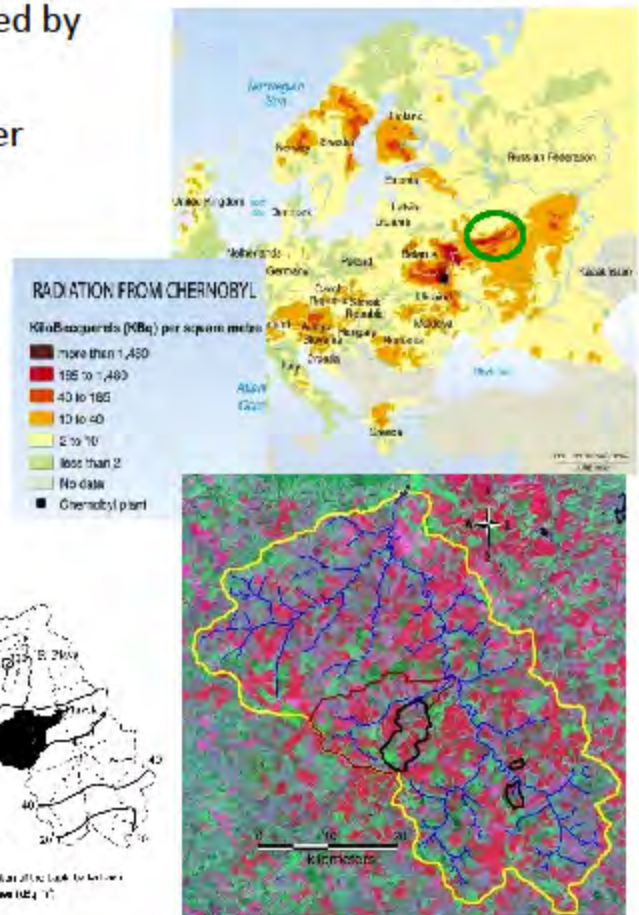
Three border region:  
Ukraine – Belarus –  
Russia

Important secondary  
contamination areas in  
Finland, Sweden, Norway  
and Austria

If we synthesize, there were two major contamination plumes one towards Western Europe and a second one towards Russia. The area where we worked – so the more red, the more contaminated by Chernobyl fallout. You have a very contaminated area around Chernobyl power plant in what I call the three border region, I mean, Ukraine, Belarus and Russia. Then you have a secondary contaminated area what they call the Plavsk hotspot in Russia, Plavsk hotspot because it's based around Plavsk town. We worked in this area.



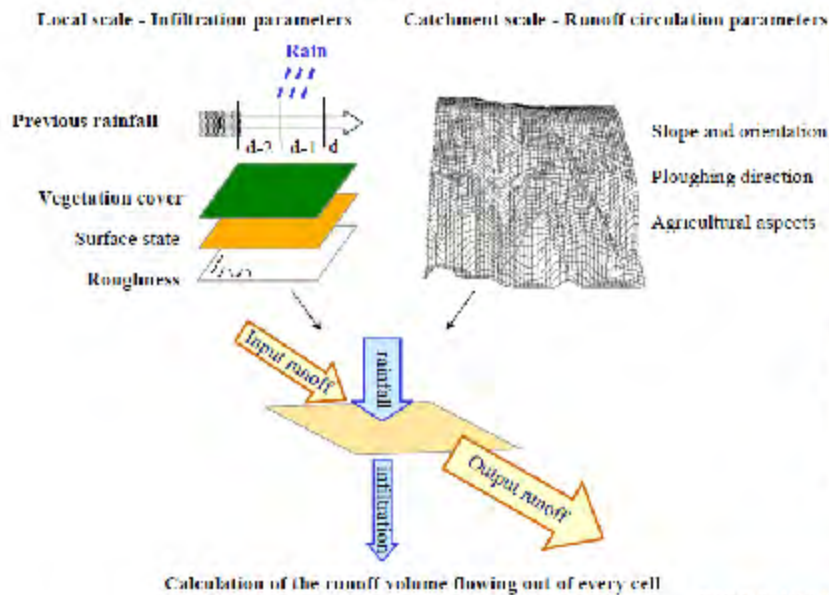
- Plavsk hotspot (Russia) severely contaminated by Chernobyl fallout in 1986
- Cultivated region draining into the Plava River
- Total catchment area of  $\sim 2000 \text{ km}^2$
- Important social and economical problems
  - Small river disappearance
  - Concentration of contaminants in dry valley systems (localised called 'balkas')
- No continuous river monitoring scheme
- Focus on a subcatchment (i.e., Lokna River) with an area of  $160 \text{ km}^2$



This area was severely contaminated by Chernobyl fallout in 1986. This fallout corresponds to more than 90%–95% of the total fallout. It means that the fallout due to the bomb test is very low in this area. It's a cultivated region draining into the Plava River and the total catchment area amounts to 2000 square kilometers. This is the Plava catchment and we worked in a small subcatchment about 200 kilometers draining into the Plava River, where the contamination was particularly high.

In this region of Russia, we had additional problems. There are rivers. There are croplands. The main concern is that the contaminated particles drain into the valleys and contaminates them, which could be a problem for food chain contamination, for example. Unfortunately, there is no continuous river or rainfall monitoring scheme, which makes it very difficult to model erosion during the last decades in the area. We wanted to find a way to obtain quantification of erosion and accumulation of contaminated sediment in the river valleys by using a model.

- Test of a runoff/erosion expert-based model
- Challenge for several reasons
  - Lack of input data
  - Suspected dominance of tillage erosion



Cerdan et al. (2001); Evrard et al. (2009)

AGENCE NATIONALE DE LA RECHERCHE  
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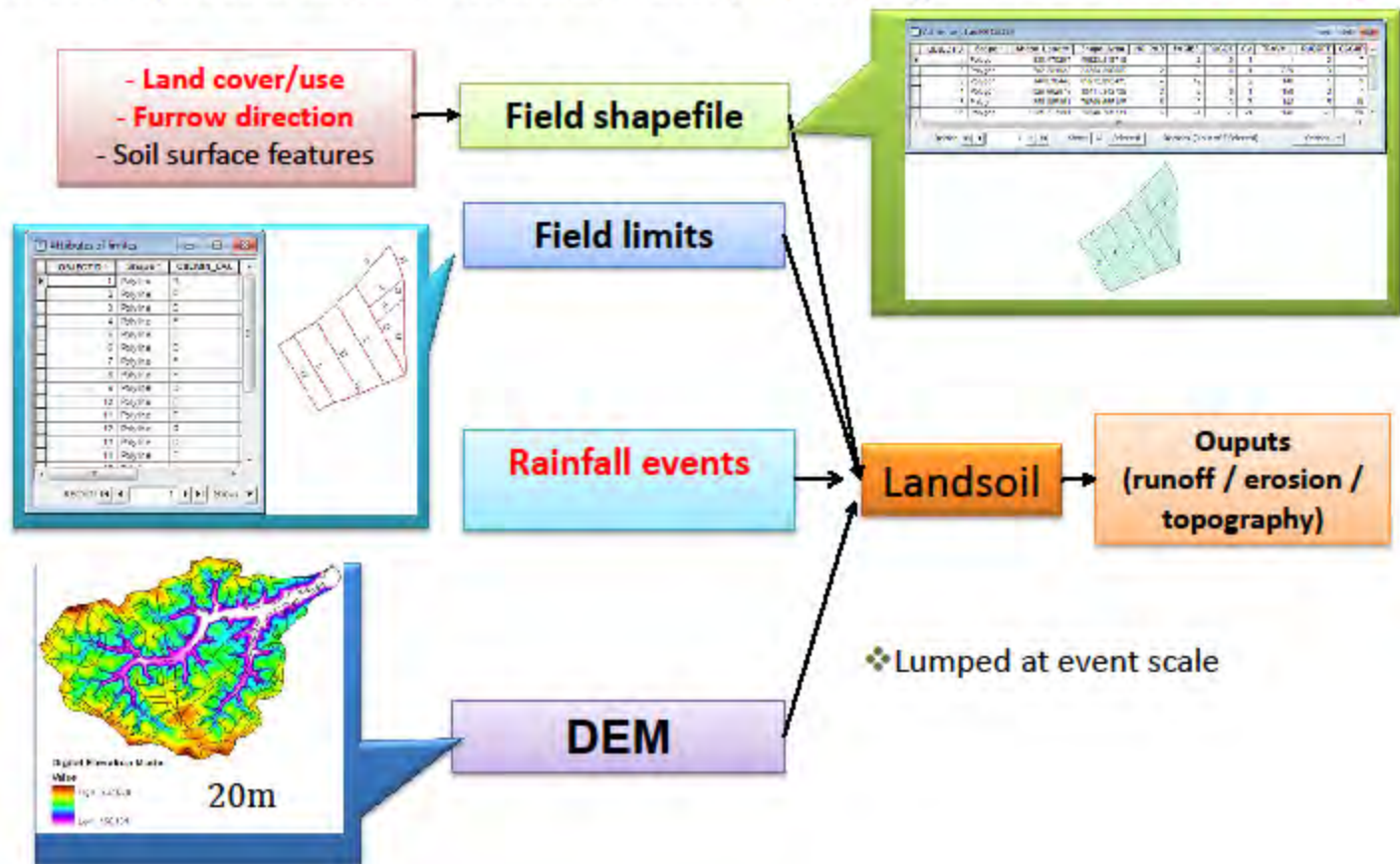
**LANDSOIL**  
Landscape and soil conservation

This model is in fact what they call an expert-based model. Why an expert-based model? Because it focuses on the main processes occurring in the area, so it's not an empirical model nor a completely physically based model, but it's based on two types of information. The first one you have, of course, the topography given by the digital elevation model. You add to this topography information, also information on tillage, so the farming practices conducted in this catchment. That's one part of the information. Based on this information, you can derive the drainage network. But what is also very important in agricultural and cultivated areas is all the surface states. I mean the vegetation cover, the soil roughness, the presence of a crust on the soil surface. For example, in this case, when you have a crust on the soil surface, when there is rainfall, you see that there is runoff very rapidly. Afterwards, this runoff can concentrate on roads or in gullies, for example.





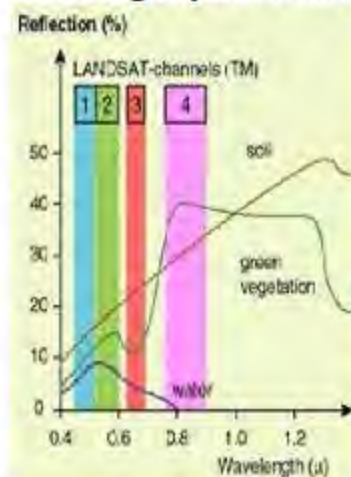
Model input data based on local information, expert judgement and **remote sensing**



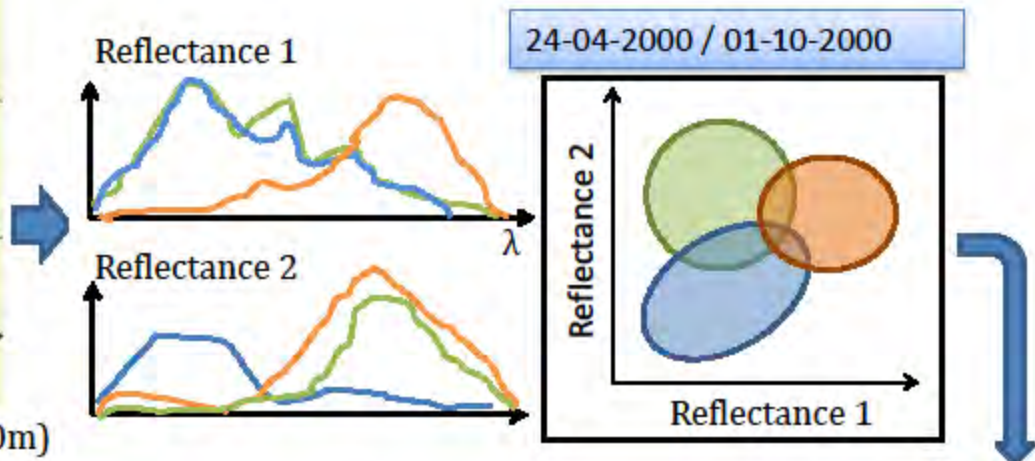
The idea of this model is to combine all of this information to obtain data on runoff and erosion at any point of the catchment. But the problem is that we have not many information, not many data in this catchment. What we need is this information. Topography, that was not so difficult because in Russia they have very detailed topographic maps and we could – just like digitizing all the control ● and obtain a rather precise DEM. Information on the different fields which you have in the area, but after you need information on what there is in this field, I mean, the cropland, grassland, what kind of crop, and so on. Information on rainfall events and based on this, you can run the model and obtain a runoff and erosion outputs.



## Deriving input data on land cover



Landsat 7 (8 bands, 30m)



## Seasonal growth of vegetation throughout the year

	January	February	March	April	May	June	July	August	September	October	November	December
Winter cereals	10-50	30-50	10-50	10-50	10-50/50-80	50-80/>80	>80/Harv/S&G	5&G/0-10	0-30/10-50	10-50	10-50	10-50
Summer cereals				S&G	0-10/10-50	10-50/50-80	50-80/>80	>80/Harv				
Potato					S&G/0-10	0-10/10-50	50-80	>80/Harv	Harv			
sugar beet root				0-10	0-10/10-50	10-50/50-80	50-80/>80	>80/Harv	Harv/S&G			
Maize					S&G/0-10	0-10/10-50	50-80/>80	>80/Harv				
legumes	0-30	0-10	0-10	0-10/10-50	10-50/50-80	50-80/>80	>80	Harv/S&G/0-10	0-10	0-10	0-30	0-30
Annual grasses	0-30	0-10	0-10	0-10/10-50	10-50/50-80	50-80/>80	>80/Harv/S&G	5&G/0-10	0-10	0-10	0-30	0-30

S&G= Semi and Germination, Harv=Harvest

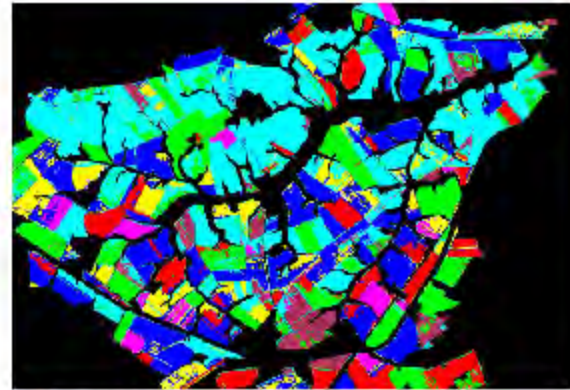
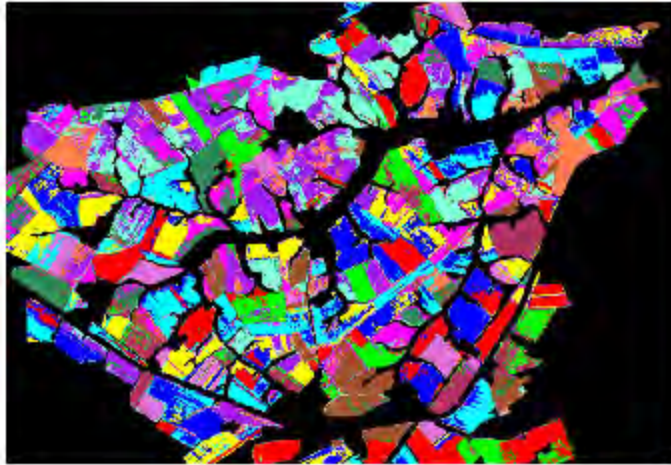
Best classification

Association with a land cover type

The problem was to obtain – I will focus on land cover of the different fields, have information on the furrow direction, and information on rainfall. We wanted to simulate erosion between 1986, so between the Chernobyl accident and, let's say, 2005. We have information on land cover because there was no local database. We have Felix ● working on remote sensing and they obtained information, satellite images at two periods during the year 2000 in April and in October. We know what are all the different crop types grown in this catchment. We know that the vegetation during the different months of the year, it evolves so the crop grows and the soil characteristics change throughout the year. Based on this information and based on the difference on the reflectance observed and retrieved from the satellite images, we could associate each fields with a given crop type.



### K-means classification (13 classes)



■ Unclassified  
 ■ Class 1 – Potatoes, Sugar beetroot  
 ■ Class 2 – Winter cereals 2000  
 ■ Class 3 – Summer cereals  
 ■ Class 4 – Legumes, Summer cereals  
 ■ Class 5 – Prairies  
 ■ Class 6 – Winter cereals 2001  
 ■ Class 7 – Fallows



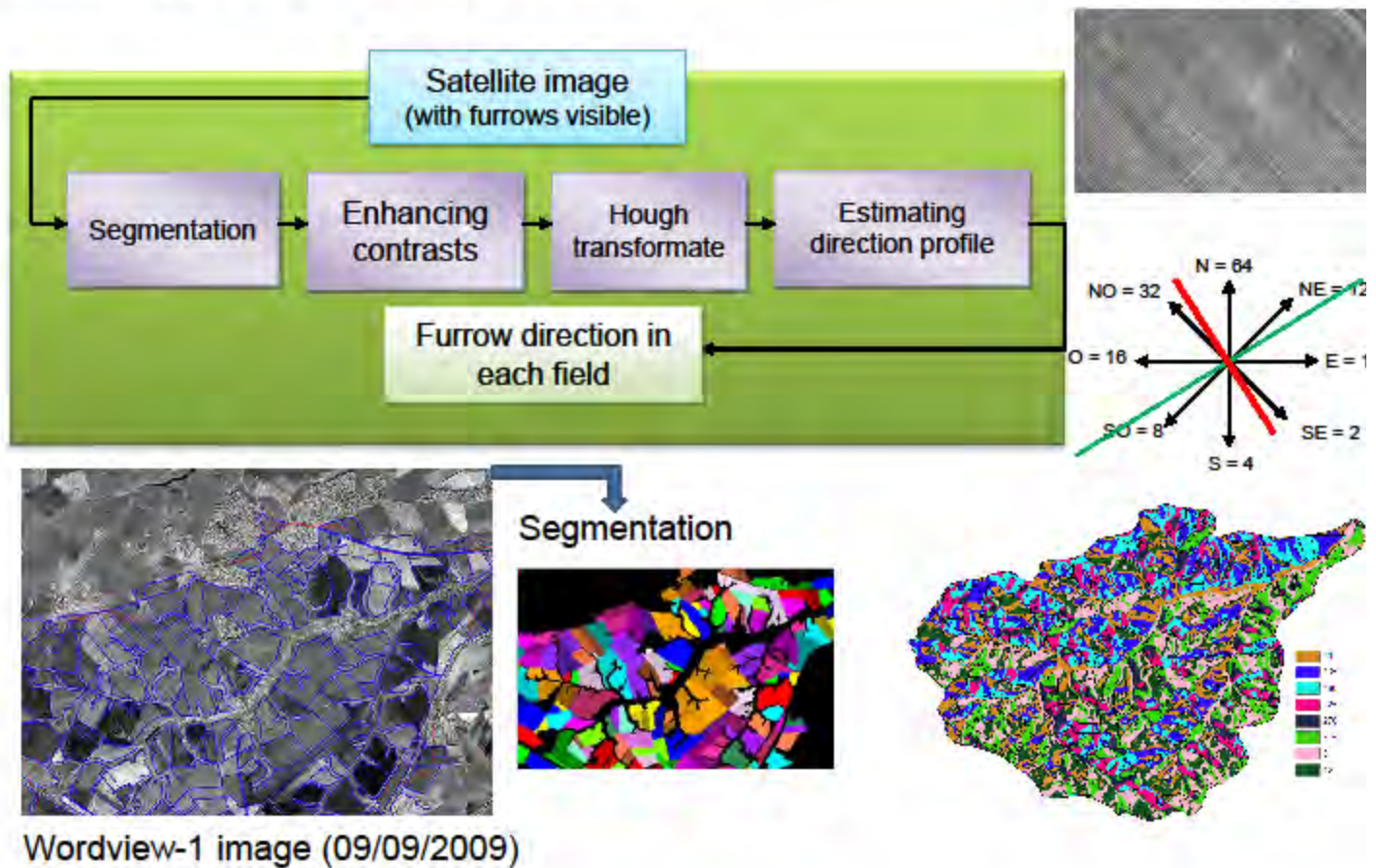
### Consistent with the available field data



■ maize  
 ■ sugar beetroot  
 ■ wheat  
 ■ prairies  
 ■ fallows  
 ■ forest

They worked on satellite image classification and could obtain a land cover map for the entire catchment. Then, they used another type of satellite images, QuickBird images, more precise, where you can detect the furrow directions. They used a type of treatment that they made automatic so that you don't have to start from each field manually to derive the furrow direction.

## Deriving input data on furrow direction

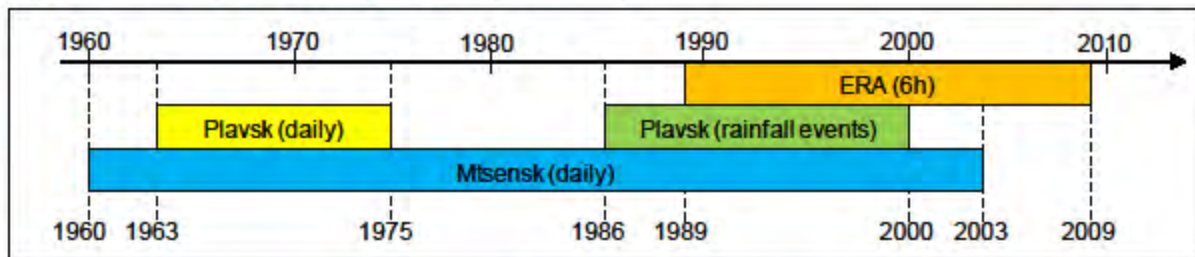


They made an image segmentation to retrieve different fields and then expected the furrow direction for different fields, which is very important to derive the flow network in the catchment. We have this information too.





## Deriving rainfall input data (1986 – present)

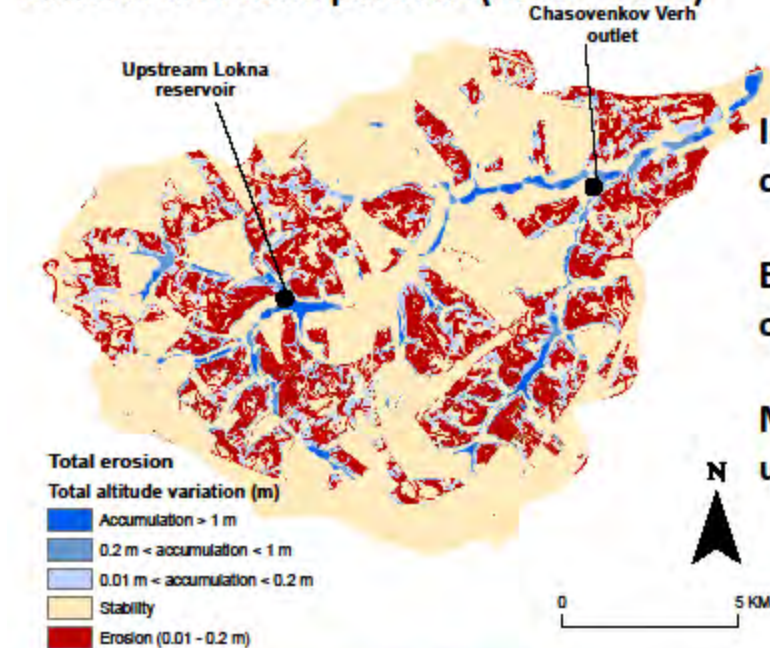


- ❖ *Required data:* rainfall depth, duration, max. intensity, antecedent rainfall (48h)
- ❖ A 6-h time step is insufficient for erosion modelling studies!
- ❖ Need to construct realistic rainfall scenarios

Type	# days	RA (mm)	D (h)	I-max (mm h <sup>-1</sup> )
Heavy storm	1	≥ 15	1	41
Storm	1	< 15	1	20
Heavy night storm	2	≥ 15	2	41
Night storm	2	< 15	6	20
Continuous rain	≥ 3	n/r	6 d <sup>-1</sup>	9

The last big problem was to have rainfall information for the entire period between 1986 and present. This is the kind of rainfall data that were available in this area. There was a rain gauge in Plavsk City with the information, but only between 1963 and 1973. Then, we also had another database detailed for different rainfall events but only between 1955 and 2000. Well, in fact it was very complicated because we had no homogenous database. We worked on different, more or less, detailed database on rainfall events. Also, European scale data to reconstruct realistic rainfall scenarios, I mean to make a classification of different rainfall events that occurs in this area: storms or low intensity continuous rainfall and so on, because the main problem when you model erosion is that you need very detailed information in time. If you have only total rainfall amount of 1 day, it's not enough to see much erosion because if you have, for example, 15 millimeters rainfall in 1 hour, it will be very different than 15 millimeters in 1 day in terms of erosion. We wanted to reconstruct realistic scenarios to take this into account.

## Simulated erosion patterns (1986 – 2003)



**Important soil movement within the catchment ( $20 \text{ t ha}^{-1} \text{ yr}^{-1}$ )**

**Erosion concentrated on cropland (mean of  $14.3 \text{ t ha}^{-1} \text{ yr}^{-1}$ )**

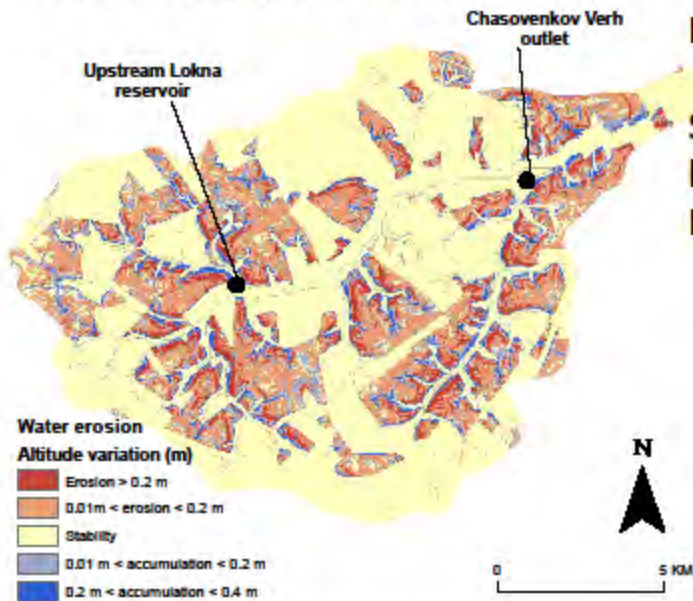
**Major sediment accumulation in the upstream Lokna reservoir**



The results. This is the total erosion pattern simulated for the 1986-2003 period. In red, erosion areas; in blue accumulation areas, so it's logical. What you see in yellow, it's the areas of forest or grassland and there was almost no movement, soil movement in those areas. In contrast, in red you have the erosion areas, mostly concentrated in croplands. In the valleys, you have the blue areas that represent accumulation. In fact, we modeled a very important soil movement within the catchment. On average, 20 tons per hectare and per year, with erosion concentrated on cropland. Then, for example in this area, a very important accumulation and it corresponds to reservoir.



## Water erosion (1986 – 2003)

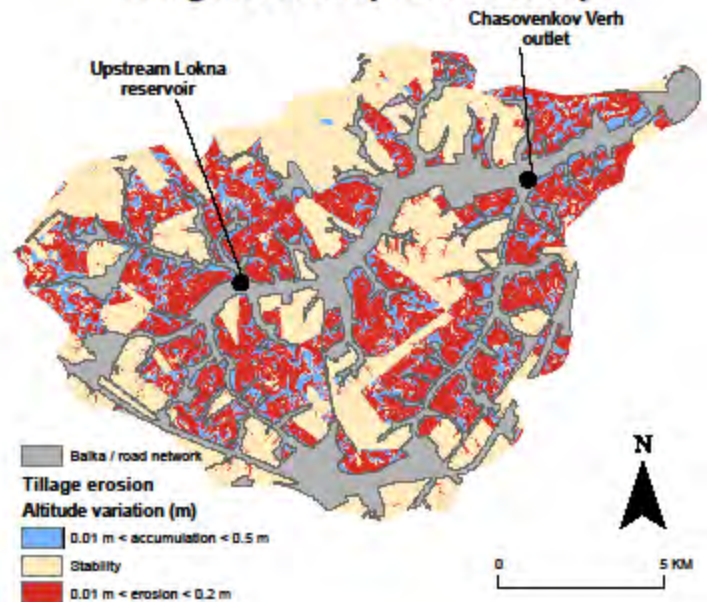


Low to moderate water erosion ( $3 \text{ t ha}^{-1} \text{ yr}^{-1}$ )

Sediment connectivity only achieved during heaviest storms

Low sediment delivery ratio (8 – 11%)

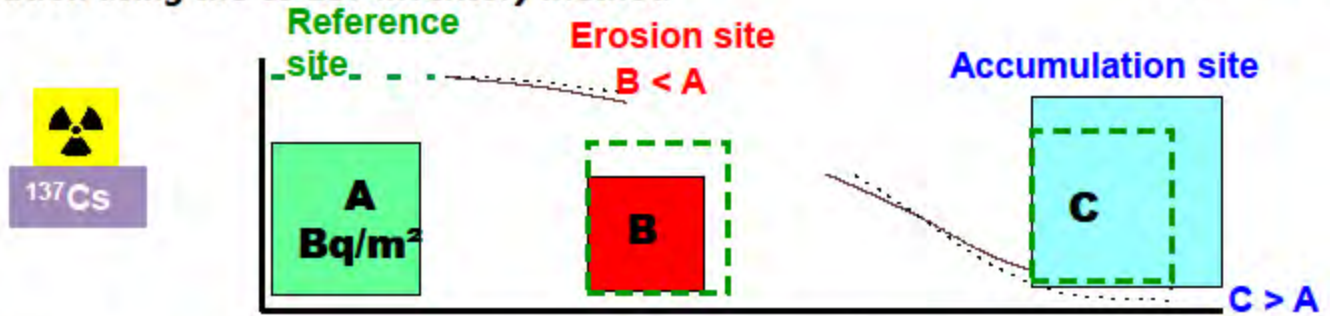
## Tillage erosion (1986 – 2003)



That was the map for total erosion, but if we separate total erosion into water erosion – this is the first map – and tillage erosion, so due to the farming practices, you see that in fact we have a very low to moderate water erosion only 3 tons per hectare and per year, but a much more important tillage erosion. You have sediment connectivity within the catchment only during the heaviest storms. That means only 10 important events during the entire period. This leads to a very low sediment delivery ratio. It means that you have important soil movements but only 8% to 11% of the sediment exported from the catchment. You have important redistribution within the catchment but low export from the catchment.

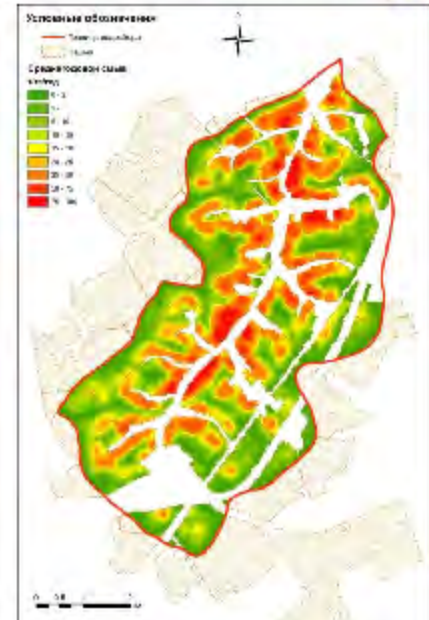


### Validation using the Cs-137 inventory method



**Results can also be compared to other model outputs**

**Sediment fingerprinting studies are also under progress (Belyaev et al.)**



Now, what we wanted to do with our Russian colleagues is to validate those model outputs with the caesium-137 inventory method. Not only with this inventory method, but also with sediment fingerprinting studies and all other model outputs. This model is a Russian model based on the Universal Soil Loss Equation, developed from the United States. For the points where we started validation, it was relevant. I mean it was consistent. The different outputs obtained with different methods were consistent.





- Landsoil erosion models provided satisfactory results
- Remote sensing provided most of required model input data
- Soil movement is important in this region of Western Russia
- Nowadays, tillage erosion is dominant
- Storms can lead to concentrated erosion
- areas
- Important sediment accumulation is modelled/observed along the dry valley systems and in an upstream reservoir
- Potential implications for human health ??



We're happy because based on satellite images-derived information we could obtain satisfactory results based on this model; that we could obtain all input data with satellite images in this area, where there weren't many inputs data available databases; that soil movement is very important in this west is region of Russia, mostly driven by tillage erosion, but during heavy storms, there is sediment exports concentrated erosion, gully erosion and export from the catchment. We also have very important sediment accumulation in the dry valley system and in upstream reservoir, and this could have potential implications for human health because this is contaminated sediment. But, in fact, this was a test that we made 3 years ago. This is the cattle output but we didn't detect caesium-137 in it. That was a good point but it was also taken more than 20 years after the accident.

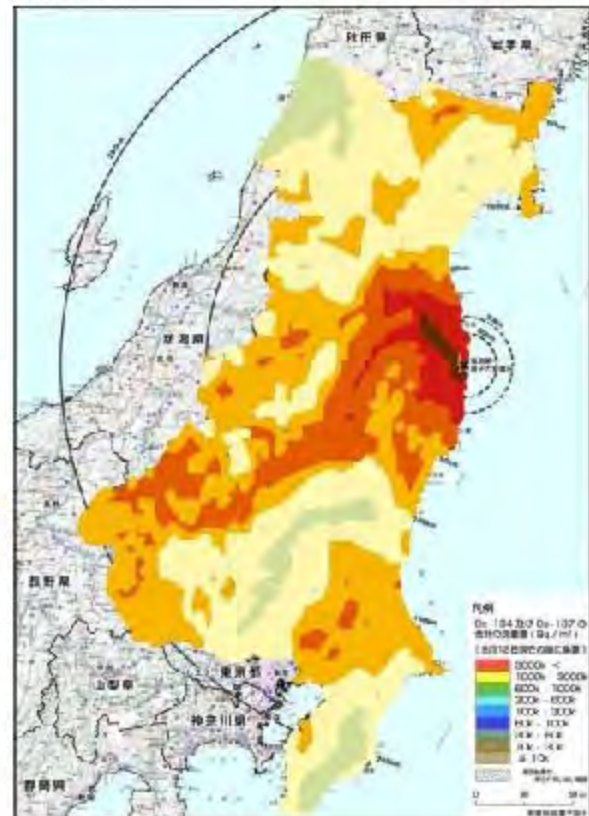
- Lessons to be learnt for studying the impacts of Fukushima accident
  - Are both contamination patterns comparable??

*Using Chernobyl impact map scale*



Source:

<http://maps.grida.no/go/graphic/radiation-from-chernobyl>



What are the lessons that could be learned for studying the impacts of Fukushima accident? The first point is that we can compare both contamination maps. On the left side, you have the contamination map in Europe after Chernobyl. On the right side, if you use a similar radioisotope activity scale, this is what you will obtain in the Fukushima region. That means that in total, the Chernobyl radioactive emissions were 10 times more important than from Fukushima. But it was spread on much more important area, a much more important surface. In Fukushima, it was spread over a much less important surface, which means that you have a very important contamination around the power plant.

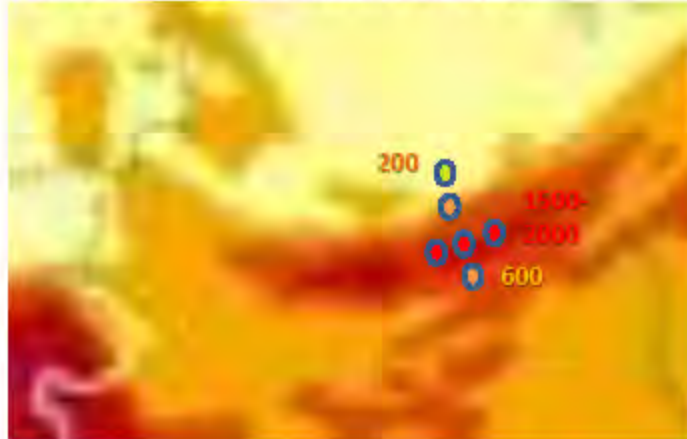


- Summer 2011: Fieldwork in the Plavsk contamination hotspot (Russia)



Counts / min ( $^{137}\text{Cs}$ )  
5-min countings

- Overall, initial airborne contamination map is correct (1993 survey).
- $^{137}\text{Cs}$  inventories at reference sites are stable all around the contamination hotspot



- We still have to calibrate with the core inventories measured by our colleagues

Then, second point is that this year we went to the field to check the initial airborne contamination map. This is a zoom on this map. We wanted to check that the initial contamination map was correct. The *initial contamination map was done in 1993. We could check. This is only the counts per minute of caesium-137.* We made 5-minute countings in the field using a portable detector and it was very consistent. We'll have to calibrate this with the core inventories measured by our colleagues in Russia, but we have actually low count numbers in the less initially contaminated area and a much larger counts per minute figures in the most contaminated area.

- Summer 2011: Fieldwork in the Plavsk contamination hotspot (Russia)



- Contamination is much higher in valleys where sediment accumulates (typically 2000 Bq kg<sup>-1</sup>, 25 years after the accident)
- At reference sites, there is still <sup>137</sup>Cs detectable in edible parts of plants (2 Bq kg<sup>-1</sup>, 25 years after the accident)
- Hotspots were locally found in villages (up to 10,000 Bq kg<sup>-1</sup> of <sup>137</sup>Cs)



Another point is that contamination is much higher in valleys where sediments accumulate. We still have, even 25 years after the accident, around 2000 Becquerels per kilogram of caesium-137 in sediment. Also, at reference sites, we still measured caesium-137 in the part of the plants that you can eat just like in wheat, in maize, in potatoes. We still found 2 Becquerels per kilo of caesium-137, 25 years after the accident. We also found contamination of hotspots in the villages, so you have just a school next to this car park and we still found in this soil up to 10,000 Becquerel per kilogram of caesium-137, 25 years after the accident.



# Many thanks for your attention!



**Picture taken by N. Ivanova (2010)**

**[olivier.evrard@cea.fr](mailto:olivier.evrard@cea.fr)**

Thank you for your attention.

# Soil surface characteristics

## Crusting



## Roughness



## Soil cover by vegetation



This was just to show the soil surface characteristics, but basically, it was what I want to tell about our work in the Chernobyl region.



- Environmental consequences
  - Local contamination of lakes, soils and vegetation
  - Forest fires; contamination of forest fauna



- Consequences on human health
  - There is a large debate... For non-specialists, it is difficult to find relevant data
  - Example of recent article:

*British Journal of Cancer* (2011) **104**, 181–187. doi:10.1038/sj.bjc.6605967

[www.bjcancer.com](http://www.bjcancer.com)

Published online 23 November 2010

**Thyroid cancer risk in Belarus among children and adolescents exposed to radioiodine after the Chernobyl accident**

10–15 years after the Chernobyl accident, thyroid cancer risk was significantly increased among individuals exposed to fallout as children or adolescents, but the risk appeared to be lower than in other Chernobyl studies and studies of childhood external irradiation

- Official UN/IAEA reports: 50 dead and 4000 people suffering from radiation consequences
- Yablokov et al.: ca. 1,000,000 victims...

**Male1**

We have questions. Thank you, Mr. Olivier. [Japanese]. Any questions or comments?

**Male2**

Let me start. Thank you very much for your nice presentation. I have two questions. Maybe, I'm not clear about these two points. The first one is you used expert model to estimate soil erosion. The parameter that you have used in this model is almost similar Universal Soil Loss Equation. What is the difference between these two models? Maybe if we finish one, and the other one after you gave the total soil erosion using this model, you divide the erosion rate into two, the water and the tillage erosion. But, what about wind erosion?

**Dr. Olivier Evrard**

Okay. I will start with second question because it's easier. There is not a lot of wind erosion in this area. It's negligible according to our colleagues, so we didn't really work on this. It's not really a driving parameter of soil movement in this area.

Regarding expert-based models, in fact, it's not really based on the same parameters and as the USLE model because the USLE model is really based on local, empirically-obtained data and on Plavsk. You have Plavsk and you derive statistical relationships valid for a given region. In this case, what we do is that it was based on rainfall simulation experiments, on soil surface states, representative of the different situations you can observe all throughout the year for different crops. It gives you an idea of the infiltration rates for the different situations. When you have rainfall on this kind of surface states, you have more or less a balance of what infiltrates and what runs off.

But then, I think that in fact this model was developed in France, in Normandy, where you have fixed deposits of loose silty soils and those silty soils are very sensitive to crusting. It means that when you have not a dense crop cover of the soil, when you have rainfall, you have very [Technical Difficulty] a crust, just like on these areas, and then you have very rapidly a runoff. I think that when you understand in which actual situations you have a potential important runoff and erosion, which is taken into account in this model by combining and associating the characteristics related to crop cover, roughness, and crusting, and that you combine it with a relevant flow network by combining the topography and all the other features that you have in the landscape and then you can drive the flow, just like the ditches, the roads, the furrow directions. I think that you obtain something that lead to relevant results. I don't know if I answered your question.

**Male1**

Maybe ask detailed – you have a question? I just want to question. In your experimental catchment, how much for that inventory of caesium-137 in the catchment that...?

**Dr. Olivier Evrard**

How much in the inventories you mean?

**Male1**

Yeah.

**Dr. Olivier Evrard**

Today or when contamination occurred?

**Male1**

Yes, today.

**Dr. Olivier Evrard**

Today? In this area, in the red area for reference sites, you have inventories of about 200,000 Becquerel per square meter, 200K Becquerel per square meter.



**Male1**

But that means 2000 – not 2000 Becquerel per...

**Dr. Olivier Evrard**

No, no. In this map, it was preliminary results. It just comes for a minute for caesium-137 with this effect because we just received the – because it's a problem to take back sediments and soil samples from Russia. The analysis must be done in Moscow. Since we did it in August and September of this year, I just received the results yesterday or within the first – but I can tell you today that this number of counts corresponds to 200,000 Becquerel per meter, more or less.

**Male1**

Okay.

**Male3**

Thank you for the pleasant talk. I would like to ask more kind of just curiosity but did Fukushima accident influenced your research activity...?

**Dr. Olivier Evrard**

Not at all. Not in Russia. In France, in Paris on the Seine River, we have a Ph.D. students working on something else on the movement of contaminants in the Seine River and we detected iodine and caesium from Fukushima. But it wasn't – we didn't know that we would detect it but it was really, really low levels but we could detect it anyway.

**Male3**

Are this campaign for Summer 2011 is just done before...?

**Dr. Olivier Evrard**

Yeah, it was done before in this area. It was just to check that the initial contamination map was correct and to have a look on what we observe 25 years after – before that after the accident.

**Male1**

Maybe, we went to the next topic of the...

Thank you.

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