Paper

CHERNOBYL POST-ACCIDENT MANAGEMENT: THE ETHOS PROJECT

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Abstract—**ETHOS is a pilot research project supported by the radiation protection research program of the European Commission (DG XII). The project provides an alternative approach to the rehabilitation of living conditions in the contaminated territories of the CIS in the post-accident context of Chernobyl. Initiated at the beginning of 1996, this 3-y project is currently being implemented in the Republic of Belarus. The ETHOS project involves an interdisciplinary team of European researchers from the following institutions: the Centre d'étude sur l'Evaluation de la Protection dans le domaine Nucléaire CEPN (radiological protection, economics), the Institute National d'Agronomie de Paris-Grignon INAPG (agronomy, nature & life management), the Compiègne University of Technology (technological and industrial safety, social trust), and the Mutadis Research Group (sociology, social risk management), which is in charge of the scientific co-ordination of the project. The Belarussian partners in the ETHOS project include the Ministry of Emergencies of Belarus as well as the various local authorities involved with the implementation site. The ETHOS project relies on a strong involvement of the local population in the rehabilitation process. Its main goal is to create conditions for the inhabitants of the contaminated territories to reconstruct their overall quality of life. This reconstruction deals with all the day-to-day aspects that have been affected or threatened by the contamination. The project aims at creating a dynamic process whereby acceptable living conditions can be rebuilt. Radiological security is developed in the ETHOS project as part of a general improvement in the quality of life. The approach does not dissociate the social and the technical dimensions of post-accident management. This is so as to avoid radiological risk assessment and management being reduced purely to a problem for scientific experts, from which local people are excluded, and to take into consideration the problems of acceptability of decisions and the distrust of the population towards experts. These cannot be solved merely by a better communication strategy. This paper presents the main features of the methodological approach of the ETHOS project. It also explains how it is being implemented in the village of Olmany in the district of Stolyn (Brest region) in Belarus since March 1996, as well as its initial achievements.**
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Key words: Chernobyl; accidents, handling; contamination, environmental; exposure, population

INTRODUCTION

Nearly 2.2 million people in Belarus live in areas legally considered to be contaminated by the Chernobyl nuclear accident in 1986. Although some 80% of these people are living in regions where the ground level contamination of ^{137}Cs remains low according to the experts (less than 185 kBq m^{-2}), there are several reasons why the remaining radiological risk cannot be neglected. The first reason concerns the complexity of the radioecological processes of re-concentration, which can lead to problematic exposure levels in certain situations, particularly for children. The second reason is based on the ethical principle of precaution, given the uncertainty of the long term consequences of a continuous exposure to radioactivity in a contaminated environment. As one interviewed local representative put it, "One should never consider as normal giving a baby a feeding bottle of contaminated milk."

European surveys undertaken in the context of the EU/CIS co-operation program to evaluate the consequences of the Chernobyl accident (1991–1995) have provided an extensive assessment (qualitative and quantitative) of the social and psychological effects of the accident on liquidators, relocated populations, and inhabitants of contaminated territories (EC 1996). Further investigations carried out in Ukraine, Belarus, and Russia have revealed strong social disturbance and stress phenomena amongst the populations of the contaminated areas (Drottz-Sjöberg 1992; Girard and Hériard Dubreuil 1994). In the areas studied, the environmental contamination is a basic concern for most of the inhabitants and creates a climate of widespread anxiety, focused on the health effects of the Chernobyl accident, especially on children. Contrary to the concept developed soon after

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the accident (1987), which introduced the idea that worrying about a radiological risk, considered negligible by many experts, was a type of psychic pathology (radiophobia), the observed anxiety refers to a real concern about an invisible phenomenon which is difficult to localize and to measure. This fear is not, in psychiatric or psychoanalytical terms, akin to a phobic syndrome (Girard and Hériard Dubreuil 1996). The inhabitants of the contaminated territories experience an overall depreciation of many different types of values: social, economic, aesthetic, symbolic, ethical, political, etc. The quality of life is perceived as being irreversibly affected: "Nothing will be the same again," as some people expressed the situation when speaking about their lives "before" and "after" the accident. This is one characteristic of the post-accident crisis, as pointed out in the early nineties when it was shown that the situation could not return to normality (IAEA 1991; Lochard and Prêtre 1995). The belief which is observed in Belarus that immunization against contamination is possible—a sort of 'return to normality'—is nothing but a type of risk denial (Girard and Hériard Dubreuil 1995).

The initial strategy implemented by the national authorities of the independent republics of the former USSR concerned (Ukraine, Belarus, Russia) to overcome the consequences of the Chernobyl catastrophe aimed at restoring a "normal situation." All post-accident laws passed in 1991 in these countries refer to the 1 mSv y^{-1} individual dose as an action level. The relocation of the population was defined according to the level of contamination of the territory (zoning process). In zones assigned to "voluntary relocation" (from 185 to 555 kBq m^{-2}; individual annual dose ranging from 1 to 5 mSv), the inhabitants were forced to make their own choice of whether to stay or to leave, faced with a new, uncertain and highly complex situation. The feeling of insecurity, the lack of trust by the population of the scientific, medical, and political authorities (Hériard Dubreuil 1994) and the impression of being deprived of means to avoid radiological hazards perceived as all-pervasive to every day life, created the general feeling of a loss of control over the situation. This loss of self confidence appears to be related to the disappearance of social trust. In this context of distrust, experts who play down the risk are perceived by the population as denying the risk, thus reinforcing mistrust and anxiety, and rendering any risk communication strategy ineffective. As a consequence of social distrust, the population no longer believes that the authorities and experts are capable of managing the radiological situation (Hériard Dubreuil et al. 1996).

The decision of whether or not to stay in a contaminated territory cannot be assigned solely to experts, no matter how low their estimation of the risk. For ethical and political reasons, the responsibility for such a decision has to be shouldered by all the individuals concerned, in order to improve acceptability and accountability of all stakeholders (Hériard Dubreuil and Girard 1997). The real issue at stake is to investigate to what extent the inhabitants of contaminated territories can rebuild their security and restore their own quality of life. Living in a contaminated area implies a strategy of risk prevention or at least a precautionary attitude towards the possible unknown future consequences of low chronic internal contamination. Economic constraints due to the recession encountered by the CIS economies and the gradual declining interest in the Chernobyl issue in the political debate of these countries also call for a direct involvement of the population in the decision making process and for a more decentralized risk management approach. Prescriptive centralized countermeasure programs face many obstacles when implemented: unable to cope with local features, rejected by local stakeholders, ineffective and expensive in the long term. Although necessary in the early post-accident phase, centralized approaches are not sustainable for long term risk management. Local authorities have to cope with the long term trend towards reduction of external contributions to the management of radiological quality and safety. In the perspective of a sustainable improvement of the living conditions in the contaminated territories, most of the choices must be contextualized at the local level and involve the local population.

THE ETHOS PROJECT

The ETHOS project has initiated an alternative approach to post-accident rehabilitation in order to better cope with the main features of the Chernobyl post-accident situation. One specificity of this new approach is that it does not dissociate the social and technical dimensions of the post-accident management. This avoids the risk assessment and management being reduced to a problem for scientific experts, excluding local people from the decision making process, and takes into account the problems of distrust of the population towards experts.

The project is based on a strong involvement of the local population in the rehabilitation process. Its main goal is to create conditions for the inhabitants of contaminated territories to reconstruct their overall quality of life and to manage, themselves, the radiological risk in the same way that rural communities manage natural risks (Ollagnon 1992). This reconstruction deals with all the day-to-day aspects that have been affected or threatened by the contamination, that is: health, (especially that of children), food, security at home, professional life, social life, environmental quality, leisure time, economic value of products, the future (especially that of children), individual and collective identities, and, finally, culture.

In order to avoid the social dynamic of loss and restriction that is observed when focusing solely on a strategy of risk reduction, the project aims at creating a process whereby acceptable living conditions can be rebuilt. Radiological security is developed as part of a general improvement in the quality of life. Since many factors can affect progress in radiological safety, as for example the economic recession, the overall quality of living conditions in the affected territories must be taken

into account if sustainable and solid progress in the field of radiological safety is to be achieved.

The ETHOS project is a 3-y pilot research project supported by the radiation protection research program of the European Commission (DG XII), and it was launched in the Republic of Belarus at the beginning of 1996. It involves an interdisciplinary team of European researchers as listed in the abstract.

A first mission in Belarus was organized in April 1996 in order to determine an implementation site given that the selection had to be based on the voluntary commitment of the local authorities. A total of 6 districts were visited in the contaminated territories of Southern Belarus, and the broad outlines of the project were explained to the local authorities. After discussions and negotiations with the various authorities, the candidate village of Olmany in the district of Stolyn (Brest region) was selected. This settlement appeared to be a suitable site for the implementation of the ETHOS project given its principal characteristics.

The village of Olmany (1,265 people) is linked to a collective farm of roughly 1,800 hectares whose main production is milk, wheat, and meat. Problematic contamination levels of privately produced food appear to be a real concern for both the population (notably the mothers) and the local authorities. Tradition is very deeply rooted in the social organization, and the population, contrary to other districts more severely affected by previous relocation policies, has a large proportion of young people (369 less than 17 y old). Only a few families with very young children left Olmany when the consequences of the accident in their village were officially recognized in 1991. Despite an on-going political debate on the possibility of relocating the population of the village (the ground caesium contamination ranging between 185 and 555 kBq m^{-2}) there was strong opposition from most of the inhabitants to leave the place. The existing social network including families with children, and the clearly expressed willingness of the population to participate in the project were of primary importance in the site selection process.

A co-operation framework was signed in July 1996 between the European research teams and the CIS partners of the project including three administrative levels: the Chernobyl Ministry of Belarus, the District of Stolyn, the Village of Olmany (the collective farm). A series of 8 missions, held between March 1996 and October 1997, led to the creation of 7 working groups (mothers, clean milk, meat quality, young people, pedagogy, collective farm, firewood and ashes) involving the local population of the village.

THE ETHOS APPROACH

The first stage of the ETHOS approach premises is to create relations and to establish mutual trust between the population and the researchers (Earle and Cvetkovitch 1995, Le Cardinal et al. 1997). Several ethical principles underpin the co-operations between the European research team and the local population. The first addresses the usual questions asked by the local population when meeting foreign experts: "Do you think we can live here with our children? Are there any risks to our health? Should we leave this territory or stay here?" As explained above, these types of questions relate to the lack of trust between the population and the experts. It was decided that the research team was not going to answer such questions, refusing to make decisions in place of the people confronted with the radiological risk. Instead, the proposal of the team was to help those having decided to stay in the village to build their security and their quality of life. This response led to questions from the population such as "What would you do? Would you come and live here with your children?", which were then answered by each team member on the basis of his personal feelings towards the situation.

The second main ethical principle relates to the responsibility of the research team towards the improvement of the local situation at the implementation site. As a result of numerous Chernobyl international post-accident surveys, the populations of the contaminated territories have a general feeling of "being treated like guinea-pigs" by the scientists "without any kind of benefit for the inhabitants in return." This makes it necessary for the ETHOS team to commit itself to improving, as far as possible, the real local situation during the lifetime of the project.

The second stage of the ETHOS approach is a process of collective learning and assessment of the local situation. Local working groups of volunteers and researchers are created with limited tasks aimed at a concrete improvement in the quality of life, integrating a radiological dimension (for example: "to provide the children with clean milk"). The relevant aspects of the radiological situation are assessed locally by means of measurements, managed directly by the population. Each work group member participates in the collection of information and existing information is checked according to European scientific standards. The working group progressively involves different individuals who have an interest in its tasks (the stakeholders). This includes the population itself, the administrative framework at the local, regional and national levels, but also the different social and economic networks concerned such as public health, agriculture and farm produce industries, retail business, etc.

The third stage of the ETHOS approach is a process of reconstruction and improvement. The creation of reliable common pictures of the radiological situation makes it possible for the local people to reassess and reconstruct aspects of life that have been threatened or deteriorated: their food, their safety (notably at home), their social and economic relations, their relation with nature, their leisure, their future, their individual and collective identity, etc. They can reassess what is still good but was until now mistakenly considered to be deteriorated. They also have to reconstruct affected aspects of daily life in developing for example new techniques for growing safe vegetables or producing

clean milk and clean meat, new economic activities coping with the radiological context and in creating new, safe leisure activities for the children.

The different working groups developed so far and their preliminary results are presented as follows.

Group 1: mothers

During the July 1996 mission most of the interviews carried out to establish contacts with the population of the village highlighted a strong concern regarding the health of the children because of their day-to-day exposure to radiation. A first meeting was organized with volunteers—about 10 mothers in the village—and several members of the ETHOS team in order to discuss this important issue more thoroughly. The discussions revealed the very approximate understanding of the mothers of the exposure pathways (external and internal) affecting their children. The lack of information to assess the radiological situation was also clearly identified as a factor causing a feeling of anxiety and powerlessness among the mothers. Based on the general willingness of the mothers and the research team to try "to do something" to improve the situation, a first working group was created with most of the mothers who were involved previously and a few members of the research team. As a first action, it was decided to gather data on the daily diet and activities of the children. Several mothers proposed to write down this information in a notebook for their own children for the period up until the next ETHOS mission.

In October 1996, the mothers' notebooks were analyzed during a series of meetings of the working group where it became evident that the data collected could not be exploited as a whole in a statistical way, but could only be used in the context of each family in order to practically improve the situation. A measurement campaign was then organized to collect information about the ambient dose rates in houses and gardens where the children play and the concentration of cesium in the food they eat. First ambient dose rate measurements were performed in a house by a few mothers with the help of ETHOS team members using a measurement protocol established by the working group. Several food samples were also prepared and brought for measurement at the school nursery where adequate equipment was available.

Following this first experience of work carried out in co-operation, the mothers decided to perform further measurements in their homes and of the food products using the local measurement equipment and devices provided by the ETHOS team. A second set of food contamination measuring equipment was installed in the village by the Chernobyl Ministry of Belarus in summer 1997 to cope with the increasing number of samples to be measured.

About 20 houses were screened by the group within a few months: dose rates inside rooms, near the stoves, and in the gardens were measured by the mothers themselves (Fig. 1) and recorded on plans that were kept at home and discussed with neighbors and friends.

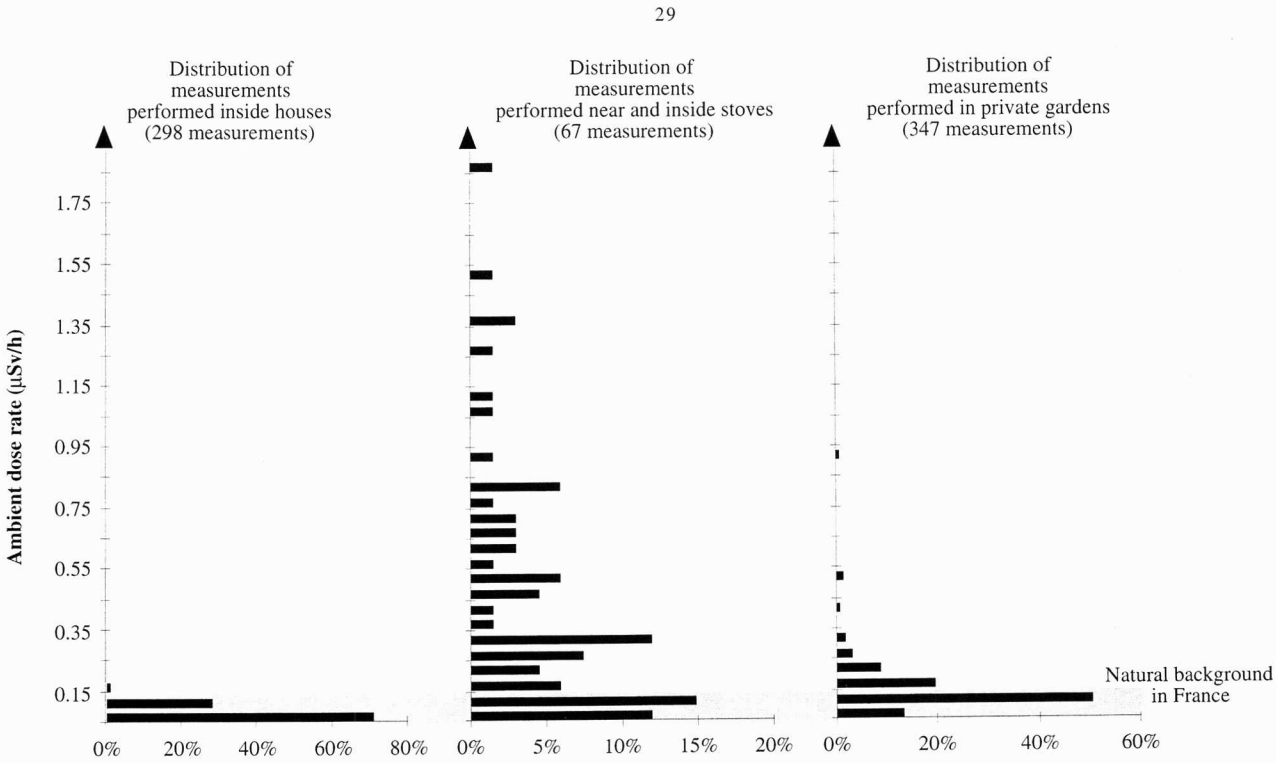

Fig. 1. Distribution of measured ambient dose rates inside rooms, near stoves, and in gardens.

An effort was also made to spread the experience and the results throughout the village. Measurements were shown to the population and discussed in the course of meetings with the inhabitants. A poster was also prepared by the mothers and put up in the entrance of the village school to inform other inhabitants and to encourage the diffusion of the work. Information on the work and the results of the group was also continuously transmitted to the different people interested in the development of the project at the local, regional (district authorities) and national levels (Ministry of Chernobyl).

The information collected by the mothers' group with regard to the ambient dose rates measured in houses, gardens, and recreational areas, as well as the study of the children's diet, revealed that the situation was far from homogeneous in the village. Some samples showed low-level ambient dose rates or categories of food with low contamination levels. Problems were pointed out in certain families where categories of food more sensitive to contamination were measured. These observations have also been correlated with the results of whole body measurements performed on children at school.

After having introduced the information about the natural background in France, the group was able to prepare a dose scale presenting, in a comprehensive way, direct information on how to behave for a given dose rate, in relation to the time spent (Fig. 2). The mothers expressed their satisfaction in regaining control over the presence of external radiation as the following: "Even if the radiation is high, we can speak about it. If it is normal, we can leave it aside. We have to be prudent and not to go where there is too much radioactivity."

The analysis of the results on food contamination and on the children's diet allowed the group to make a better assessment of the daily intake of radioactivity. It appeared that the situation was different for each family, and that the daily intake of radioactivity was very sensitive to particular categories of foodstuffs—milk, berries, mushrooms—which directly influence the total ingestion by several orders of magnitude for a given diet. Table 1 shows, for two different children, the variation of their daily ingestion associated with their own diet, depending on the contamination of the food.

This evaluation had direct consequences on the group's attitude towards the children's diet. The mothers reached a stage where they were able to manage the daily ingestion of contamination by their children by selecting food with a lower contamination rate. The acceptance or rejection of a food product because of its propensity to be highly contaminated became a responsible choice to be made by the family. Moreover, these reflections led to the elaboration of an ingestion scale in reference to annual budgets ranging from 20,000 to 100,000 Bq y^{-1} and were adopted as a reference for this scale and allowed a direct link to be made with the limits on contamination levels adopted by the national authorities.

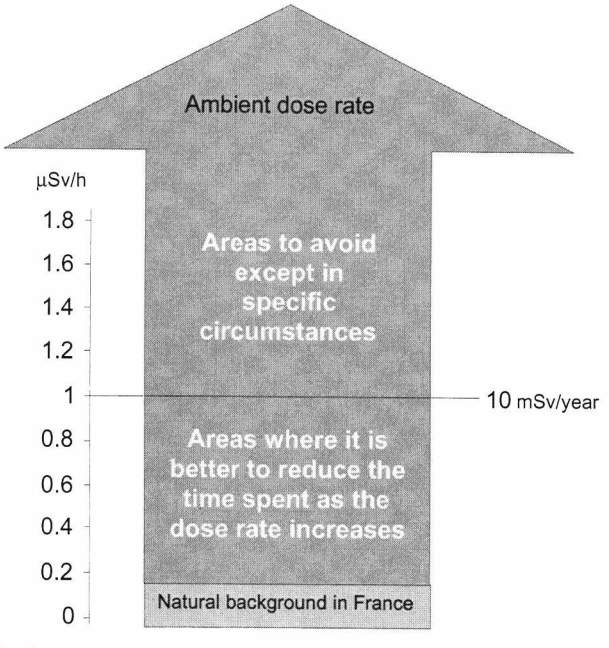

Fig. 2. Dose rate scale adopted by the mothers' group.

Group 2: clean milk

Direct interviews with the population of Olmany in July 1996, and a series of meetings with private milk producers, revealed a strong concern over the daily consumption of contaminated milk by babies and children. Discussions with many producers progressively drew a picture of the way the village population perceived the contamination of the milk, seen as a generalized and irreversible phenomenon. Meanwhile, many producers expressed a shared willingness to try to better protect their children with respect to the ingestion of contaminated milk.

During the first mission, a group of several volunteer producers and members of the ETHOS team collected the existing information on the contamination of private milk in the village for the year 1995. These measurements were provided by local and regional authorities, resulting from a periodic survey of the contamination of foodstuffs, conducted in the village since the Chernobyl accident. The results (Fig. 3) caught the interest of many producers. On the one hand, the large proportion of very contaminated samples confirmed that the population faced a serious milk contamination problem. On the other hand, the diagram showed that "clean milk" (below the regulatory limit of 111 Bq L^{-1}) was also available in the village, and this was interpreted very positively.

The idea to isolate this clean milk progressively emerged from the group's discussions. The implicit existence of clean pastures led some members of the group to envisage the creation of a specific sub-herd of cows in order to provide babies and children with clean milk. However, this general objective of producing non-contaminated milk uniquely for the children was not directly conceivable without a clearer view of the real situation. Finally, 10 voluntary producers decided to get

Table 1. Survey of the children's daily ingestion of radioactivity with food contamination levels and dietary sources. Contamination levels generally have a precision of ±30%.

Product	Contamination range[a] (Bq kg^{-1})	Situation 1		Situation 2	
		Diet[b] (g)	Ingestion[c] (Bq)	Diet (g)	Ingestion (Bq)
Bread	10–60	250	2.5–15	200	2–12
Butter	30–400	10	0.3–4		
Vegetable soup	10–100	100	1–10	100	1–10
Meat	10–300	100	1–30	100	1–30
Stewed apples	10–100	150	1.5–15	500	5–50
Sauerkraut	10–50	300	3–15		
Rabbit	10–300	100	1–30		
Potatoes	10–100	100	1–10		
Stewed berries	100–2,000	200	20–400		
Potato soup	10–100	200	2–20		
Cocoa milk	10–2,000	100	1–200		
Stewed potatoes	10–100			150	1.5–15
Buckwheat porridge	10			50	0.5
Milk	10–2,000			100	1–200
Omelette with dripping	0–10			120	0–1.2
Salted cucumbers	0–100			100	0–10
Lard	10–300			50	0.5–15
Total (Bq d^{-1})			34.3–749		12.5–343.7

[a] According to the measurements performed by the "Mothers' group," the "Milk group," and the "Meat group."
[b] Estimates from the "Mothers' group" results.
[c] Min and max values according to the contamination range observed.

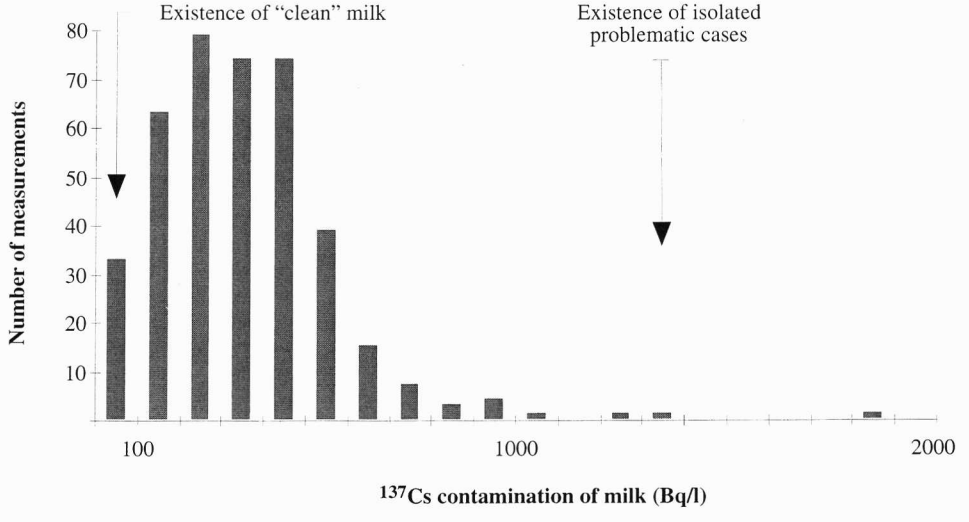

Fig. 3. Distribution of milk measurements performed in Olmany in 1995.

involved in an attempt to establish a "map of the milk production" in the village to clarify the origins of the contaminated milk.

In a first step, the producers involved in the milk group focused their efforts on the measurement of the contamination of milk, hay, and pastures. As far as possible, local measurement equipment was used. A key factor at this stage was the progressive construction of a common and reliable understanding of the problem of milk contamination by the local and European participants.

Between the successive missions of the ETHOS team, the 10 voluntary producers coordinated the measurement campaign with other producers in the village. They organized the milk survey and helped other producers to get involved in the project. Measurement protocols and guidelines were elaborated in co-operation with the research team. The results were systematically shared and discussed during meetings tackling the various aspects and difficulties of the work.

Besides the radiological aspects, the results of "milk mapping" allowed a better appraisal of the whole organization of private production and its strong interactions with the collective farming system. In particular it revealed two distinct organizations according to the seasons: individual production in winter and collective production in summer. In winter, each producer manages

individually his resources. In summer, private cows are rounded up into 7 herds to which pastures are allocated by the collective farm.

This collective assessment played an important role in the dynamics of the working group. The improved comprehension of the situation led to a tightening of the objectives with the possibility of implementing concrete actions with locally available means. Furthermore it broadened the panel of people involved, opening new opportunities for negotiations and improvements at different levels—local (collective farm), regional (district), and national (Ministry of Chernobyl).

At each stage of the measurement campaign, the results were discussed by the group, the ETHOS team helping the producers to interpret their measurements and to point out specific problems. Possible means of improvement were classified into three categories: individual, common or collective actions. The first category includes actions that an individual farmer can carry out in an independent way such as optimizing the winter distribution of clean and contaminated hay on a private farm. The second includes actions that can only be achieved through co-operation between individual farmers such as for example re-orienting the summer herds. The third category of actions are those that can be undertaken by one person accountable to the entire community as for example the retail of clean milk by the collective farm. In each case it was decided whether the proposed action was being undertaken at the most appropriate level of action: individual, common, or collective.

The re-assessment process led to considering possible concrete actions to improve the situation such as looking for new "clean" pastures for the herds concerned, creating sub-pastures with the less contaminated parts of the existing "grazing routes," and the setting up a sub-herd devoted to the production of "clean milk" for children. All these suggestions were evaluated by the group taking into account their respective cost, complexity and expected effectiveness, in order to set up a program of actions for summer as well as winter production.

During the summer, the information collected by the producers on milk contamination pointed out specific problems concerning two of the 7 herds in the village due to the fact that they were grazing on non-improved pastures. After negotiations between the private producers and the collective farm, herds 1 and 2 were re-oriented in August 1997 towards improved pastures, i.e., pastures on which deep ploughing, followed by re-seeding and fertilization had been performed as one of the national countermeasures adopted after the Chernobyl accident in the contaminated territories. This reorganization was made possible because of the consensus obtained between all the producers concerned and the collective farm. Significant improvements were already observed by the end of summer 1997 (Fig. 4).

During the winter each producer manages his own resources, which results in a wide distribution of milk contamination between the producers. Milk samples

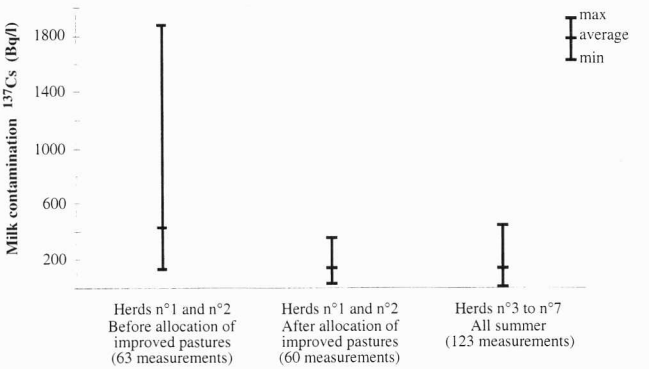

Fig. 4. Distribution of measurements during the summer period (1997) for herds 1 and 2 before and after their re-orientation on improved pastures and for herds 3 to 7.

measured during winter 1997 were discussed with a panel of the farmers experiencing problems of milk contamination. These discussions led to about 10 producers reorganizing their milk production taking into account their available winter resources: distribution of hay according to its level of contamination and the lactation period, distribution of cesium binder [ferrocene $Fe_4(Fe(CN)_6)_3$] adapted to the hay contamination and feeding of the animals with complementary foodstuffs when available (beets, potatoes). Each voluntary farmer prepared a protocol with the help of the research team for the winter of 1998, taking into account the calving periods and the available quantities of different qualities of hay and ferrocene.

Group 3: meat quality

From the beginning of the project, the quality of meat emerged as another concern for the inhabitants of the village. Most of the meat (pork, poultry and eggs) produced in Olmany by private farmers is used as subsistence for families. The inhabitants did not really know the level of radiological contamination of their meat production but the overall situation of their village led them to think that it was highly contaminated. Private producers were worried about giving their family possibly contaminated meat products, and some families did not even want to know the level of contamination of the meat arguing that in any case they were obliged to eat it.

Contacts with all the people involved in the meat production and retail (private producers, collective farms, shops, market) in the Stolyn district helped to draw a general picture of how meat is produced, transformed, sold, and eaten.

Most private producers expressed a preference for selling the meat at a reasonable price to the market of Stolyn. However, considering that they have to slaughter the animals and pay the transport to Stolyn without any guarantee of being able to sell the meat because of possible contamination, in practice they only produce meat for their own needs. As far as live calves are concerned, they are sold by the farmers to the collective farm at a low price. The collective farm then feeds the

animals with clean food for a period of 40 d in order to remove the contamination before selling them to the abattoir at Stolyn. It is not known why there is a need for such a cleaning process since the level of contamination of the live calves when sold by the farmers is not controlled; the radiological contamination of the meat is only measured afterwards at the abattoir.

The various contacts with the private meat producers of Olmany led to organizing a first meeting with volunteers in April 1997 during which the creation of a "meat quality" group was decided. The research team and the meat producers together defined three goals. Considered as a precondition to any further actions, the first aim was to assess the level of contamination of the meat for private production. The second was to provide the children with clean meat all year round, and the third was to market the clean meat private surplus.

For the first action, protocols were designed by the participants for the most important categories of fresh meat. Pork was selected since it is most commonly consumed in the village as is veal, which was selected because many farmers want to market it instead of selling it to the collective farm. The product selected lastly were the eggs since they form part of the children's breakfasts.

Pork and eggs were measured first and the private producers were struck by the results which showed a relatively low contamination. Twelve pieces of pork were measured in 1997 and only one sample was higher than 200 Bq kg^{-1}. The contamination of the eggs was below 25 Bq kg^{-1}. A map of Olmany was drawn in order to identify the origin of the measured eggs. The measurement campaign is still going on.

In order to be able to directly market their calves, the producers of the group also decided to develop a protocol to measure the external dose rate in contact with the animals in order to assess the potential quality of the meat in the village. First tests were made with private producers at Olmany and the abattoir at Stolyn in April 1997.

In July 1997 the meat quality group organized two meetings in order to look for means to improve the radiological quality of the meat and the incomes of the producers. Different individual situations were analyzed in detail. Reducing the radiological contamination of meat appeared to be difficult since the producers could not change the feeding of their herds, except in the case of veal production, which could lead to an increase in the contamination of the milk as explained below.

A typical situation in Olmany is that of a farmer owning two cows and a calf and contaminated as well as clean hay. If he wants to produce clean milk, he can give the clean hay to one of his cows and use the clean milk for his family. The contaminated hay is then given to the other cow whose contaminated milk is given to the calf which in consequence will become contaminated. Conversely, the farmer can give the clean milk to the calf in order to produce clean meat though in this case he will then be short of clean milk to give to his family.

Adaptation to the seasons was also examined by for example feeding calves with contaminated milk in summer when the animals are fattened and then "cleaning" them with clean food in autumn before slaughtering. The meat quality group decided to work with the clean milk group to study more thoroughly these different cases in order to identify means of avoiding dilemmas such as "clean milk for children" or "clean meat to increase families' income."

Several means to increase the producers' incomes were discussed. According to the first results, the contamination of the meat in Olmany is generally low enough to be sold to the abattoir or even at the market place in Stolyn. This last solution would allow the producers to increase their income approximately threefold. However, it was acknowledged that such an approach would be facilitated if a quality certification system for the meat production process was established to reassure potential buyers. As a result, the group members decided to study the creation of a local pilot laboratory in Olmany, where private producers could assess the global quality of meat (not just the radiological contamination) as a starting point for setting up a certification system involving the other retail personnel at the abattoir, the shops, and the market place.

Group 4: young people

Since the beginning of the project the ETHOS team tried to establish contacts with the young people of Olmany (between 16 and 25 y old). However, this important social category for the future of the village was difficult to involve in the project, and it was only in July 1997 that the creation of a working group with young people became possible.

A preliminary step was to gather knowledge about the interests and occupations of the young people in order to make contact with them and establish mutual trust. Interviews and small group discussions were carried out during the successive missions. These interviews showed that the young people were not interested in the radiological issue. During the February 1997 mission several possible projects or activities were proposed by the research team to the young people; some of the proposed activities provoked their interest. The group eventually decided to make a video production using equipment provided by the research team. Although the young people expressed many fears of failing in this task, it was decided to form a group to produce a video presenting the life and experiences of the young people as inhabitants of Olmany. The underlying goal was to enable the young people to express their emotions regarding their everyday life in a contaminated environment.

In July 1997, a training session was organized to explain to the members of the group the proper handling of a video camera and its associated equipment. This material was handed over to the newly formed video group, following the signing of a formal contract between the research team and the group, to ensure an accountable usage of the equipment. It was also decided

by the participants that the video group would first make small films to learn the technique. After several discussions, the video group proposed to film the various facets of a year in the life of the village comparing behavior before and after the Chernobyl accident, and a "scenario" presenting the seasonal activities in the village was finally adopted.

During the October 1997 mission, the ETHOS team met with the video group to review their progress. The young people described the difficulties and successes they had experienced during the making of six short films of about 20 min each depicting various aspects of their life in the village such as harvest time and fishing in the local rivers and lakes. Additional technical training was provided to the participants.

The development of the video group has not yet led to a re-assessment and reconstruction of the role of these young people in their daily life. They are still in the process of discovering the extent of their own capabilities and initiatives. However, it is expected that through the process of making a film, the young people will start to see their situation differently as they recount their own versions of daily events. This modified vision will hopefully become part of a more widespread reconsideration of the aspects of their daily life that were deeply affected as a consequence of the Chernobyl accident. If the quality reached in the first recording is maintained, the videos will be used by the young people as a means to encourage meetings and discussions with those young people in the village not involved in the project.

Group 5: pedagogy

Children appeared to be at the very heart of the concerns of the population, and so contacts were established with the school of Olmany with the objective of assessing the radiological impact on the daily life of the pupils. Discussions with the school Headmaster, the school nurse, the librarian, and several teachers allowed the ETHOS team to familiarize itself with the local situation and its consequences for the children.

In order to gather together some material to be analyzed, a first co-operation with the teachers was set up. Children were asked to prepare school essays describing their daily life and activities throughout the year to be sent to the children of a French school. Half a dozen classes participated in this activity, aged from 11 to 16 y old. Some 98 essays were gathered. This material was translated and analyzed by members of the research team. A selection of 20 letters was sent to the children of a French school in a village in Normandy. Replies from the French children were then sent back later on to Olmany.

The analysis of the letters revealed the problems encountered by children confronted by the contamination problem which represents, for them, a very complex situation. Notably, difficulties in coping with the various inconsistent aspects of their daily life were observed. For example, despite mentioning the high contamination of the forest surrounding the village and the official restrictions concerning the consumption of products from the forest, several children described the daily activities in the forest that they enjoyed and the pleasure of consuming the products from the forest. Another feature was their description of their summer stays in Europe, organized by humanitarian organizations to help those living in a contaminated territory, which consequently led them to having the feeling that they were ill regardless of their actual state of health. It also appeared that the children were confronted with social and ethical incompatibilities characteristic of the post-accident situation, which could have possible worrying consequences on their future development.

These findings led the ETHOS team to start a project with the school of Olmany and its 350 pupils in order to help them to cope with this complex post-accident situation and to build a more coherent picture of its various facets since this was a strong concern expressed by the teachers. As a result of a discussion between the school Headmaster and the research team, it was decided to create a pilot pedagogical project involving 3 teachers aiming at the development of practical work with the children relating to the radiological situation of the village. This project was also discussed at the District level with the authorities in charge of education.

Until summer 1997, the teachers involved have actively developed their respective tasks. During the following missions the progress was discussed and support was provided to the teachers. Eventually, the classes involved completed their projects by preparing a set of posters describing the food chain contamination, the evolution of the demographic aspects of the village since the Chernobyl accident, as well as a series of maps showing the geographical characteristics of the village and its surroundings.

This pilot action between the teachers and the children was a first attempt to address together both the objective reality of the contamination in the village and its theoretical aspects as developed in the school books. Another aspect of this experience was the change in the usual relationships of the teachers with the pupils. The teachers experimented with a new kind of co-operation with the children by participating together in the gathering and interpretation of the available information.

Based on this first experience, a reflection was led with the teachers, the school Headmaster and the district educational authorities in order to define the basis for a second project with the school. The objective is to create conditions for the children to better cope with the different facets of the complex situation they are facing and to establish a concrete link between the theoretical knowledge, which is currently dispensed at school, and the practical dimensions of everyday life in a contaminated environment.

Group 6: collective farm

The first contacts with the collective farm in July 1996 revealed the economic difficulties it faced, and particularly the growing problems related to the implementation of the program of countermeasures enforced

by the national authorities after the Chernobyl accident. Several meetings with the collective farm management at the beginning of the project led to a better understanding of the different economic and practical aspects of the local implementation of these countermeasures and their sustainability in the Belarussian political and economic context.

Information collected by the ETHOS team in Olmany during the first year of the project pointed towards the significant interactions existing between the private production system in the village and the collective farm production. Progressively, the role the collective farm could play in the progress of the working groups emerged and its first direct involvement took place in April 1997 in relation to the improvement of the private milk production, in particular with the allocation of improved pastures in the summer and the provision of clean hay in winter. Furthermore, the data collected by the milk group during the summer clearly showed that the contamination of a significant part of the private production was below the limit accepted for milk processing, while the fraction of the private milk production above this limit could be used by the collective farm to feed young calves. These findings were discussed by the milk group, the research team, and the economist of the collective farm in view of a possible common management of the private and collective milk production.

During the July 1997 mission, the district authorities organized a meeting with the ETHOS team, the President of the collective farm of Olmany, and two other Presidents of collective farms in the district to discuss the possibilities of enlarging the ETHOS project outside Olmany. A series of visits were organized in the two collective farms, each facing very different situations both in economic and radiological terms. These visits allowed the research team to identify new factors affecting the production in the district of Stolyn but also new opportunities to improve, or at least to maintain, the radiological quality of the products in the general context of economic recession.

Group 7: firewood and ashes

The measurements of ambient dose rates in houses, performed by the "mothers' group," revealed higher dose rates close to and inside stoves. The mothers and the research team members agreed that this situation did not raise a serious problem with regard to the daily exposure of children because of the very short time they stay close to the stoves. However, the question of the possible impacts of the ashes that are generally spread over the gardens as fertilizers was raised, and the question of the use of firewood for heating houses, cooking meals, and heating up water for laundry was also addressed.

This question caught the interest of the mothers, who collected and measured the contamination of ashes from several stoves in the village. The ^{137}Cs contamination levels observed ranged from 15,000 to 80,000 Bq kg^{-1}. Starting from a crude estimate of the ashes production in the village, based on discussions with the inhabitants (4 buckets of 4 kg each per household per week, over 500 households during 7 mo of the year), this led to the calculation of a total production of ashes of about 224 t y^{-1}. Assuming an average contamination of 50,000 Bq kg^{-1}, this corresponds to a total activity of 11,200 MBq y^{-1} "produced" by the village. If we consider that all ashes are spread onto the gardens in the village (600 m^2 each), the annual input is about 37 kBq m^{-2} y^{-1}, i.e., 26% of the initial deposition of 187 kBq m^{-2} in this area (Fig. 5). This additional contamination resulting from the spray of contaminated ashes in the gardens caught the attention of the mothers involved, in addition to several foresters, who expressed their interest in investigating this problem in more detail notably to check if it has significant impact on the exposure of the population.

During October 1997, a member of the district forestry authorities living in Olmany took the responsibility for investigating the origin of the firewood used in the village, its contamination, the quantities involved, as well as the corresponding quantities of ashes produced and their final uses. An assessment protocol was established with the ETHOS researchers. Depending on the nature of the first results a decision will be made as to whether or not a new working group should be created with the objective of looking for ways to reduce the radiological impact of the ashes.

A FIRST APPRAISAL

Eight missions representing about 400 person-d have been accomplished since the beginning of the ETHOS project allowing real progress in the seven ongoing working groups aiming at concrete improvements in the radiological security and quality of life in the village of Olmany.

The process of collective learning and assessment of the local situation allows both the population and the research team to draw a common picture of the situation and to validate collectively each piece of information.

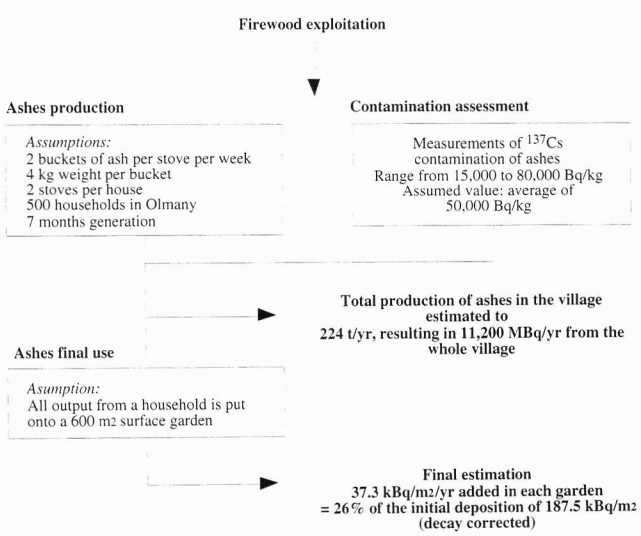

Fig. 5. Rough estimation of ashes production.

The research team does not make its own assessment to be communicated afterwards to the population. The primary goal is the creation of a context in which the radiological appraisal makes sense for the local population in order to achieve concrete improvements with available resources. It is now noted when discussing with participants of the different groups that their perception has shifted from a feeling that a "dark grey" picture persists to the existence of a more contrasted one with some much clearer aspects of the situation.

The measurements performed continuously by the "mothers' group", in addition to those of other groups in the village, such as the "milk group" and the "meat group", have provided information on which the mothers rely on completely, and from which they can base their choices for the children's protection. The mothers have built a common picture of the situation in their houses, and this re-construction of quality at home has brought about real changes in the perception and management of the radiological risk.

During the process of reconstruction and improvement, the participants have discovered significant potential for progress to improve the situation with the available resources, which they previously thought impossible. The lack of resources was previously considered by all participants to be a definite obstacle to an improvement in the radiological situation. Although limited, these emerging local indications of improvement are all the more important given that the present lack of resources will remain a real problem in the future—in the political and economic context. They are also of primary importance in the restoration of self government and self confidence in the population.

Until now the "mothers' group" has demonstrated that it is possible to regain control of the management of the radiological situation at the family level through an individual approach. The mothers have also discovered that individual actions as regards the contamination could improve the situation with the existing resources. For example, adapting the time children spend in an area according to the local dose rates measured, or by controlling ingestion of contamination through the food given to the children, and choices such as deciding whether or not to feed their children products particularly sensitive to contamination. As a member of the group said during a meeting, "If we are told what not to do or where not to go, we don't care, but if it depends on us, it's different."

These means of improvement result from different factors such as examining problems specifically rather than generally. Using average measurements conceals the real problems as well as the available solutions. In many cases, the exposure has to be assessed on an individual basis in each specific context. Opportunities for progress also arise when the local population is provided with new techniques or methods. They appear in the working groups when individuals or institutions (stakeholders) work together to achieve common goals of high priority (such as the health protection of the children). This, of course, depends on the number of stakeholders involved in the process. More co-operative stakeholders usually bring about more opportunities to improve a situation.

While starting with the findings of a few local volunteers aiming at one specific task, each group progressively extends or modifies its goals and actions to improve the situation. The relevant stakeholders then pursue the revised goals. This process is a sort of dialectic between the structure of the group (the social system) and the proposed goals of the group (the project) thus making it possible to gradually restore normal interactions (economic, political, cultural) in the social network that have been shaken or broken by the accident.

The progressive involvement of the stakeholders in each step also makes it possible to propose some acceptable changes to the different stakeholders as regards the radiological situation by taking into account not only the radiological risks but also the other risks at stake for the different categories of actors involved. For example, the political situation may be influenced by an increase in public information and knowledge, and the loss of incomes resulting from selling unmeasured products from the forest that may be contaminated. Not taking into account the other various issues at stake leads to strong resistance to change, making it impossible to improve the situation.

An extensive list of some 50 success criteria for the ETHOS project (classed under four main headings: radiological safety culture, quality of life in the village, local self government, co-operation and social trust) was drawn up by the research team and discussed with its partners at the local, regional, and national levels in Belarus. The commitment to improve, as far as possible, the real local situation (one of the main ethical principles of the project) was incorporated into all the sub-projects, thus excluding any research that would not lead directly to some kind of improvement according to the above mentioned criteria. Results not leading to concrete improvements would therefore be considered a failure by both the local partners and the research team. Within the four broad categories of success, the first achievements can be summarized as follows.

In terms of radiological safety culture, the involved inhabitants (about 1/4 of the adults) together with the research team have built common representations of the radiological situation prevailing in the village, such as the food contamination process, the contamination pathways in the environment (pasture, forest), the ambient dose rates, the resulting external doses, etc. They can now manage for themselves the current radiological measurements such as ambient dose rates and food contamination, and they have a better understanding of the basic radiological concepts.

In terms of quality of life in the village, inhabitants have discovered significant means to reduce their radiological exposure (external and internal doses) and notably the doses to children. Private farmers have identified

actions to improve the radiological quality of their production (notably milk) through a better use of available resources (clean and improved pastures, ferrocene, clean hay, etc.) and the first positive results were observed last summer. The project will certainly improve the economic value of the local products and resources as soon as a certification system is implemented for managing the radiological quality of the products.

In terms of self government of the local population, inhabitants of the village have voluntarily participated in working groups for which objectives have been collectively set up. They have taken initiatives for successful actions that they previously thought impossible. There is a growing self confidence in the population of the village.

In terms of co-operation and social trust, there is an observable effect of the ETHOS project on the social climate in the village. The project allows a better co-operation between the local inhabitants and the existing administrative framework. In general, the local decision makers are showing a growing interest in expanding the existing experience. However the conditions for reproducibility of the approach have to be developed and demonstrated.

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