Final Report of the PREPARE project

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PREPARE

Innovative integrated tools and platforms for radiological emergency preparedness and post-accident response in Europe

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PREPARE(WP8)-(16)-03

Final Report of the PREPARE project

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Management Summary

The document contains the final report of the PREPARE project. It is identical to the report submitted to the EC page, but contains all figures and tables.

Project co-funded by the European Commission within the seventh Framework Programme (2007-2011)		
Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Contents

1 Summary

The PREPARE project (Innovative Integrated Tools and Platforms for Radiological Emergency Preparedness and Post-Accident Response in Europe - http://www.prepare-eu.org/index.php) aimed to close gaps that have been identified in nuclear and radiological preparedness in Europe following the first evaluation of the Fukushima disaster. Among others, the project addressed the review of existing emergency preparedness and response procedures for dealing with long lasting releases, cross border problems in monitoring and food safety and further developed missing functionalities in decision support systems ranging from improved source term estimation and dispersion modelling to the inclusion of hydrological pathways for European water bodies. In addition, a so called Analytical Platform has been developed exploring the scientific and operational means to improve information collection, information exchange and the evaluation of such types of disasters. This has been achieved through a collaboration of industry, research and governmental organisations in Europe. The project started February 2013 and ended January 2016 and consisted of 45 partners from Europe and the Fukushima University from Japan. The activities of the PREPARE project have been performed in seven work packages with their main achievement listed below:

- **Operational procedures for long lasting releases**: Following the Fukushima Daiichi accident a review of existing EPR procedures for long lasting releases and identification of possible needs for improvements by performing scenario calculations has been performed on a European level. Suggestions for improvements have been formulated
- **Platform for information collection and exchange**: The so called Analytical Platform for information exchange in time of nuclear or radiological crisis allows discussion between institutional and non-institutional experts on an expert-level and to widespread congruent information on the current situation to the public including mass media.
- **Management of contaminated goods:** Stakeholder panels have been prepared and panels had meetings in 10 European countries to review existing guidance and to identify areas for improvement. The outcome will support designing and strengthening the preparedness plans for post-accidental situations at the national and local levels in European countries.
- **Improvement of decision support systems**: The atmospheric dispersion models implemented in the two DSS ARGOS and RODOS as well as the hydrological model chain of RODOS were extended. Among others, two methods for source-term estimation were developed and implemented. The long-term watershed model MOIRA was integrated and the global ocean model MyOcean was linked to RODOS allowing to use the simulations of this model as boundary conditions for the simulation of radionuclide dispersion in RODOS.
- **Communication with the public**: The overall objective of the work package was to investigate the conditions and means for relevant, reliable and trustworthy information to be made available to the public. Here traditional and social media were studied.
- **Training, exercises and dissemination**: Training and exercising was an important aspect of any RTD development and therefore treated as a separate work package. The content of the final meeting will be published as special issue in the French journal Radioprotection.

As a conclusion one can state, that PREPARE closed gaps identified in the European response to the Fukushima disaster. PREPARE is a step forward in harmonisation of emergency management and rehabilitation preparedness in Europe as it provides tools and methodologies which are either used in national organisations and implemented in decisions support systems such as ARGOS and RODOS, but also involving non-governmental stakeholders to gather and disseminate trustworthy information.

2 Summary of the project context and the main objectives

Following the Chernobyl disaster, significant progress was made in the area of radiological and nuclear emergency management and rehabilitation. In particular in the last years, the multi-national project EURANOS, funded by the European Commission and 23 European Member States, has integrated 17 national emergency management organisations with 33 research institutes and brought together best practice, knowledge and technology to enhance the preparedness for Europe's response to any radiation emergency and long term contamination. Key objectives of the EURANOS project were to collate information on the likely effectiveness and applicability of a wide range of countermeasures, to provide guidance to emergency management organisations and decision makers on the establishment of an appropriate response strategy and to further enhance advanced decision support systems (DSS), in particular, RODOS but also ARGOS and MOIRA, through feedback from their operational use. Furthermore, the project aimed to develop guidance to assist Member States in preparedness for nuclear and radiological emergency response and recovery and to maintain and enhance knowledge and competence through emergency exercises, training and education.

In 2011, the collaborative project NERIS-TP (http://www.eu-neris.net/) with 19 partners was established. It has two points of focus: the first is on topics that were not addressed within EURANOS; and the second is on operation of a Platform on emergency management and rehabilitation preparedness that will be self-sustainable from 2014 onwards. This platform is where the scientific and operational community can exchange and discuss research needs to further improve radiological and nuclear emergency management and rehabilitation in Europe.

Communication within the NERIS platform and among operational organisations immediately after the start of the releases from Fukushima in March 2011 was clearly disappointing. In particular the estimation of a potential source term was never harmonised on a European level. Furthermore, issues such as food safety and monitoring of passengers and goods from Japan caused problems in terms of implementation and harmonised response in Europe.

Emergency centres were overwhelmed with requests for dose assessments in Japan. However, this was made difficult due to a lack of information on source terms. Furthermore, none of these centres was ready or able to perform analysis for releases into the Ocean. With the on-going release lasting for about one month, doubts were also expressed by various organisations on the adequacy of the operational procedures for such long duration releases.

The PREPARE project (http://www.prepare-eu.org/index.php) has been created to close gaps that have been identified in nuclear and radiological preparedness following the first evaluation of the Fukushima disaster. Among others, the project should address the review of existing EPR (emergency preparedness and response) procedures for dealing with long lasting releases, cross border problems in monitoring and food safety and further develop missing functionalities in decision support systems ranging from improved source term estimation and dispersion modelling to the inclusion of hydrological pathways for European water bodies. In addition, as the management of the Fukushima event in Europe

was far from optimal, a so called Analytical Platform will be developed exploring the scientific and operational means to improve information collection, information exchange and the evaluation of such types of disasters.

The objectives of the work activities can be summarised as follows

- Our first objective is to test the current off-site nuclear emergency planning in European countries with accident scenarios based on lessons learned from the Fukushima accident and to derive recommendations how to improve the current planning. The tests should demonstrate whether protective measures foreseen in the current emergency planning could adequately reduce the radiological consequences of NPP accidents with long lasting severe releases similar to the release from the Fukushima-Daiichi NPP. This task will include several national emergency centres as well as research organisations providing the necessary tools and skills for the technical realisation of the task.
- A second objective is to develop scientific methods and tools for an Analytic Platform to act as a focal point for the collection of an analysis of information from any nuclear or radiological event, particularly regarding the consequences and any further developments. The intention is to set up such a Platform on a scientific level and discuss within the three years of the project to which extend such a platform should be formalised either as part of the NERIS Platform or on a European level. Even if the task is related to the demonstration of technical capabilities, also operational procedures for the possible operational use should be derived.
- The third objective is to develop strategies, guidance and tools for the management of contaminated products, taking into account the producers, sellers and consumers viewpoints. Such an activity will help in designing and strengthening the post-accidental situation preparedness plans at the national and local levels in European countries. It provides the opportunity to launch a European reflexion on the establishment of a more comprehensive and adaptable system, based on the principles of justification and optimisation.
- The fourth objective is the improvement of the terrestrial models of the two decision support systems ARGOS and RODOS, in particular related to the assessment of the potential source term via dispersion calculations and monitoring information and the treatment of more particle sizes, important in case of releases of fuel particles. In addition, the dispersion models should be optimised allowing to use them for longer lasting releases. This is necessary, as state of the art Lagrangian particle models have still a high computational demand but operational centres require results within tenth of minutes.
- The fifth objective is to close the gap between existing hydrological models such as the MOIRA system designed for the longer term assessment and the hydrological model chain of RODOS developed for rivers, lakes and oceans. A further task is the improved customisation capability by coupling the hydrological model chain to global ocean models allowing to use the water current all over the world as input information for the local one-dimensional or three-dimensional models to simulate the behaviour of the radionuclides in the aquatic environment. Finally, the simulation models should be tested with data from the Fukushima disaster.
- A sixth objective, is to investigate the conditions and means for relevant, reliable and trustworthy information to be made available to the public at an appropriate

time and according to its needs during the course of a nuclear emergency as well as during the post-emergency phase. Here traditional and social media will be investigated. Information flow following the Fukushima disaster should be analysed including also social and ethical aspects of the information management.

- Training and dissemination is the seventh objective aimed at the wide spread use of new products developed within the project. In addition to training courses, technical exercises will be used to test and introduce organisations to these new tools.

Important to note here is also the engagement with Japanese scientists under the umbrella of the NERIS Platform and the NERIS-TP project. This collaboration will allow further insight into the Fukushima disaster and how this will be treated in the future. To make this link sustainable, collaboration with the University of Fukushima and CRIEPI in the frame of the improvement of the aquatic models and contaminated goods is foreseen.

3 Description of the main S & T results/foregrounds

The research activities of the PREPARE project can be subdivided into the following categories

- Operational procedures for long lasting releases
- How to deal with contaminated goods?
- Improvement of the decision support systems ARGOS and RODOS in their atmospheric dispersion and aquatic simulation components
- Communication with the public to assure the trustworthiness of information
- An Analytical Platform for the information gathering and exchange

3.1 Operational procedures for long lasting releases

In all countries with nuclear installations detailed emergency management strategies have been developed in the past. In nearly all cases such strategies are based on accident scenarios where the duration of the release of radionuclides to the environment is limited to some hours or at maximum a few days. The Fukushima accident has demonstrated the possibility of long-lasting releases of radionuclides from a nuclear power plant over several weeks. This made it necessary to test the current off-site nuclear emergency planning in European countries with accident scenarios based on lessons learned from the Fukushima accident and to derive recommendations how to improve the current planning. The tests should demonstrate whether protective measures foreseen in the current emergency planning could adequately reduce the radiological consequences of NPP accidents with long lasting severe releases similar to the release from the Fukushima-Daiichi NPP.

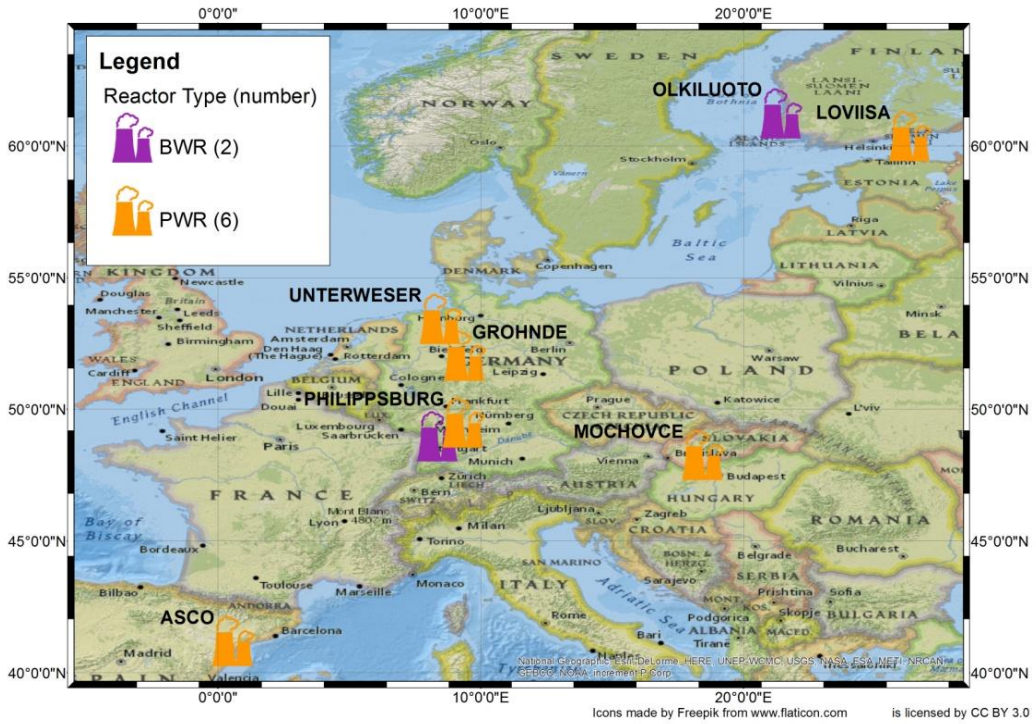

Figure 1: NPPs used for the release scenarios

The first step was to define hypothetical source terms leading to long-lasting releases of radionuclides which are applicable to nuclear installations in various European countries.

In total 10 source terms have been identified for different reactor types such as PWR, BWR and VVER. The accident scenarios leading to the accidental releases of radioactivity included core melt followed by total core damage scenarios in all cases, combined with containment damage in 7 cases, while in the remaining 3 cases releases occured through venting. The duration of the releases varied from 22 to 188 hours. Most of the scenarios can be grouped in the INES 7 scale (with 2 cases rated as INES 6 and one case as INES 5) and the amount of ^{131}I released in the 10 scenarios varied between 3 to 600 PBq.

In the second step, weather data for the release scenarios were derived. As four countries participated in the work activity, four different data sets were used. All in all seven nuclear power plant sites in Europe were included in the calculations (see Fig. 1). Some countries selected numerical weather data covering a complete year, typical for the average weather conditions in the country, whereas others used statistically derived typical weather conditions for particular times. In one case also weather conditions monitored at the site with a 10 minutes interval was used. For each of the 10 source terms between 46 and 365 weather scenarios were considered. The combination of weather and source term resulted in several thousands of dispersion calculations. This large set of calculations resulted in a wide range of results, which provided an excellent basis for the final evaluation. The selected approach proved to be a valuable tool for evaluating the applicability of current EPR concepts also for long-lasting releases.

The results of the calculations were evaluated in terms of dose and concentration fields. In particular areas and distances where national intervention criteria were exceeded have been identified (some examples for this kind of results are shown in Fig. 2).

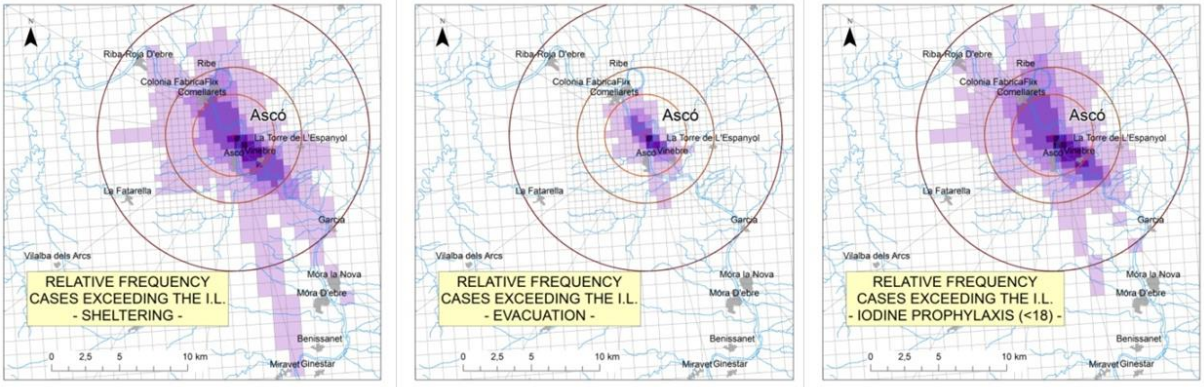

Figure 2: Frequency of cases exceeding Spanish intervention limits

In the final step, the results were compared against the existing national emergency management planning procedures. Due to the wide variability of source terms and weather conditions, this study provided a very good basis to compare the existing procedures with respect to long lasting releases. Conclusions were derived for the following questions:

1. Are the current emergency planning zones sufficiently reflecting the potential radiological impact of long-lasting releases?
2. Is the current concept of emergency planning zones as being implemented in various countries reasonably applicable for long lasting releases?
3. Are current intervention criteria appropriate for long lasting releases?
4. Will the ICRP criteria of 100 mSv for the residual dose be exceeded?

In most release scenarios the areas calculated for protective actions did not exceed current planning zones. In the cases where these distances were exceeded, the amount of affected population remained quite small. The number of sectors affected increased clearly with the duration of the release. If the release duration was less than 12 hours, the affected sector was limited to less than 90 degrees in most cases. For very long lasting releases, however, the whole circle area (around the release point) could be affected (up to 360 degrees).

Related to the discussion about intervention criteria, the following conclusions were derived, differing in the various countries:

- According to this assessment the intervention criteria (in Nordic countries) seem to be appropriate for these kinds of long-lasting releases. As the considered scenarios were severe INES level 7 accidents (for Finland), it can be assumed that the criteria are suitable for less severe scenarios also.
- In the Nordic countries "partial sheltering" is included as an additional protective action in emergency planning and response, which does not exist in most other countries. It will primarily be implemented at longer distances from the accident site or to protect children and pregnant women specifically. The intervention criteria for partial sheltering are lower than that for normal sheltering and thus the amount of population affected by this countermeasure can become rather large. During partial sheltering it is recommended not to spend time outdoors unnecessarily. Such a protective action is much easier to recommend than totally sheltering indoors.
- There may be problems in the implementation of protective measures in the short term, since the release time can exceed even the stipulated time to determine the need for evacuation or temporary relocation.
- In case of long lasting severe releases the critical situation can occur, that intervention criteria for protective actions are not exceeded in any 7-day-interval (for which some of the reference levels are currently defined in Germany), but the total dose over the release period by far exceeds the reference level.

The current intervention criteria in all countries assured, that the residual dose in the first year (ICRP reference level) did not exceed 100 mSv. Even if the general findings support the current planning, some shortcomings were identified:

- For very long lasting releases sheltering indoors inside the EPZ is probably not as suitable as in cases of a short release.
- In case of long lasting severe releases the protective action "sheltering" may impose additional problems (e.g. the danger of being forced to order late evacuation even during passage of the plume, lifting of sheltering in one area while ordering in an another area), which endangers the applicability of the action in general.
- In case of long lasting severe releases a one-time intake of stable iodine often is not sufficient for protecting the population against large thyroid doses. Multiple intakes of stable iodine tablets may not be sufficiently considered in emergency planning.

As a side activity, also the consequences with respect to drinking water were investigated. The following summaries their findings

- In case of a nuclear accident surface water can be contaminated by high levels of radionuclides and may not be suitable for drinking water production.

- Advanced treatment processes as ion-exchange and reversed osmosis do remove radionuclides effectively, but these are not common practice.
- Soil passage (dune infiltration, river bank filtration, groundwater) are a safe barrier for I-131 and Cs-137.
- If surface water is the main direct source for drinking water production, emergency plans for drinking water supply are needed.
- Drinking water utilities in the European countries are required by the EU Drinking Water Directive to provide emergency drinking water in case of a major accident, including nuclear accidents.

During the testing of the current off-site nuclear emergency planning in European countries with accident scenario simulations as described above, some issues could not be analysed or investigated in sufficient detail and thus may be considered in future research within this field of work. Issues that remain to be investigated in future include e.g.:

- Compare guidance related to lifting of countermeasures in different countries and – if existing! – check for applicability for long-lasting releases.
- Investigate effect of long-lasting emissions on monitoring strategies and capabilities.
- Conversion of release rates to measureable quantities (dose rates, air concentrations) to study preparedness related to monitoring.
- A long lasting low release rate of atmospheric discharge would probably require a very large capacity in air-sampling monitoring.
- Identification of possible problems related to quantification of deposition during (residual) release.
- Study relative influence of peak releases and long lasting (residual) low release rate discharges to total impact and protection strategies.
- Check implementation of EU BSS (in different countries) on suitability for long-lasting releases.
- Is evacuation during passage of the plume nearly always preferable against sheltering (as stated in IAEA EPR 2013 document)?

3.2 How to deal with contaminated goods?

Recommendations related to quality control of contaminated goods were already existing before the Fukushima disaster worldwide (IAEA, Codex Alimentarius) and in Europe (Euratom regulations). However, following the Fukushima accident the organisations that had to deal with these guidelines realised that they are very generic (based only on criteria in activity concentration) and many adaptations had to be developed for their operational use. To overcome these shortcomings the PREPARE project aimed to develop strategies, guidance and tools for the management of the contaminated products, taking into account the views of producers, processing and retail industries and consumers. This will help in designing and strengthening the preparedness plans for post-accidental situations at the national and local levels in European countries.

Eleven countries through 14 organisations have been involved in the discussion about the management of contaminated foodstuffs and other goods, after a nuclear or radiological event.

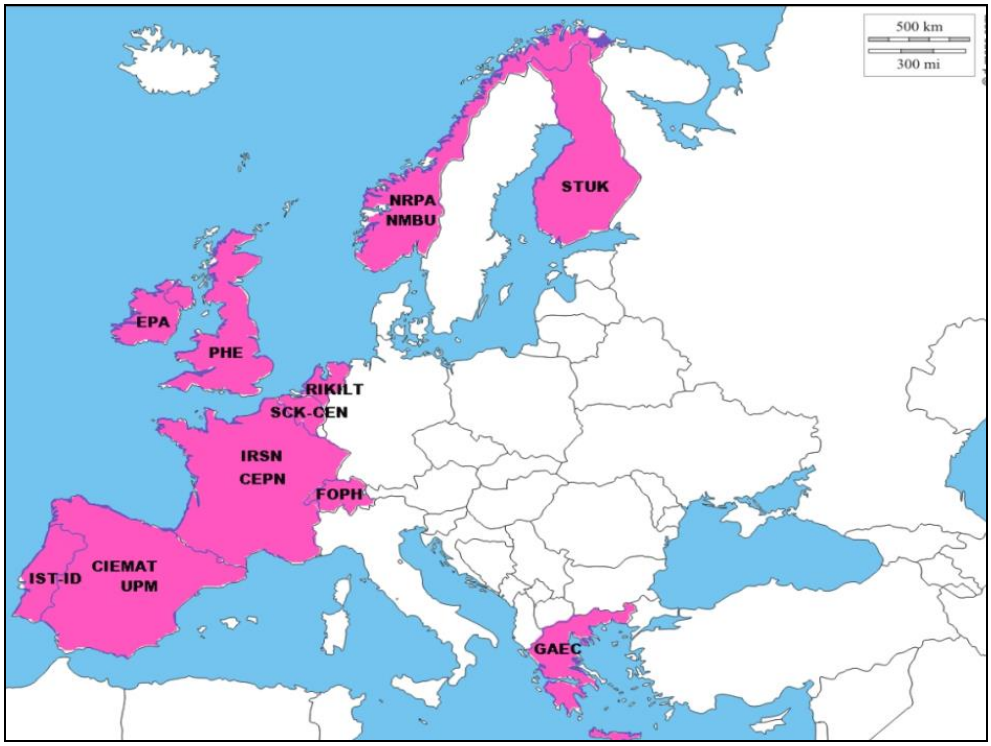

Figure 3: Countries participating in the study

Several Task Force Meetings were organised to discuss a common framework and methodology for the organisation of stakeholder panels and to exchange the first results or lessons of each national panel. A final Task Force Meeting was held later in the project. The results of the national panels were presented by the Task Force Members; two Japanese experts were invited to present their experience in the management of contaminated goods after the Fukushima accident.

The table below summarizes the methodology adopted by each country and shows that the majority of countries focused their reflection on foodstuffs (and sometimes feedstuffs). The framework of the panel methodology was defined during the First Task Force meeting in Madrid, but each country was encouraged to adapt the flexible method to its national

context. In this way, various methodological approaches were used for the composition of the stakeholder panels and the organisation of the panel meetings.

Belgium	Contaminated foodstuffs and other consumer goods
Finland	Contaminated industrial products
France & Switzerland	Contaminated foodstuffs
Greece	Contaminated ships, trucks and containers, and foodstuffs
Ireland	Contaminated foodstuffs
Netherlands	Contaminated foodstuffs/feedstuff
Norway	Contaminated foodstuffs/feedstuff
Portugal	Contaminated foodstuffs/feedstuff and other consumer goods
Spain	Contaminated foodstuffs/feedstuff and other consumer goods
United Kingdom	Contaminated scrap metal and other consumer goods

Table 1: Approaches used in the various panels

A Final PREPARE workshop was organised in cooperation with the NERIS Platform on November 12-13, 2015 at OECD-NEA in Paris. This workshop was an opportunity to discuss and share the PREPARE WP3 results in the presence of national stakeholders (consumers, producers, retailers) coming from the different national panels involved in WP3. Japanese colleagues (CRIEPI, University of Fukushima, producers and consumers NGO's) were invited to give testimonies and feedbacks on the follow-up of the Fukushima accident. An open discussion was launched at the end of the workshop with international organisations (EC, FAO, OECD-NEA, IAEA, HERCA, ICRP) during a round table. More than 90 participants attended this workshop. The following issues were addressed:

- Market, trade, economic aspects and management strategies
- Resources and capabilities, monitoring strategies
- Information strategies and decision-making process
- Management of other goods than foodstuffs and feedstuffs
- Preparedness and stakeholder participation process

The conclusions are available as deliverable in the project. Some general conclusions can be summarised in the following three points:

- Everything must be done to avoid any accident. Indeed according to the panellists, citizens are victims first, and they are not responsible for the situation arising from the accident. In addition, the presence of artificial radioactivity in the environment is always illegitimate, even if the corresponding exposures are low.
- A post-accident situation would be totally new for everyone. This is so unexpected that it will lead to a loss of references and values for all the people. Upstream preparedness - before an accident occurs - is obviously crucial, but nobody will be fully ready if it happens. Only a pre-established distribution of roles of the different stakeholders will allow a quick response.
- The concept of Maximum Permitted Levels (MPLs) is useful but questionable. According to the stakeholders, MPLs are needed but their rationale is complex to

understand. The definition and values of MPLs must be flexible and need to be adapted to the actual situation. They should be based on monitoring results as soon as possible, and should follow a graded improvement process.

3.3 Improvement of the decision support systems ARGOS and RODOS in their atmospheric dispersion and aquatic simulation components

3.3.1 Atmospheric dispersion and deposition

As a consequence from Chernobyl and again following the Fukushima disaster, source term estimation was identified as critical and extremely difficult to realise at the early stage of an accident. Further to this, the chemical and physical properties of the particles released might often deviate from the simple approach so far realised in the European decision support systems ARGOS and RODOS. To overcome these shortcomings, the estimation of a potential source term based on a combination of atmospheric dispersion calculations and monitoring data around a power plant as well as the physico-chemical properties of radionuclides emitted to the atmosphere were tackled within PREPARE.
A review was prepared providing an overview of deposition velocities and relations on different surfaces and different weather conditions. Also indoor-outdoor particle concentration relationships and deposition on indoor surfaces are described for particles of the different relevant sizes which were analysed. Based on the review, five different particle sizes were proposed for the dispersion models. They comprise small particles around one micron and heavy particles up to 60 micron. As boundary condition, the gravitational settling velocity for particles larger than 10 micros will dominate the deposition process. These 5 different particle sizes were realised in the dispersion models in the two systems and a deposition scheme which is compatible with the existing one developed and implemented.

The European Model for Inhabited Areas (ERMIN) has been modified and the deposition groups have been increased and renamed as particle groups to reflect that the solubility of particles and the presence or absence of fuel particles is an important consideration in the recommendations. Also the number of release scenarios has been increased to four. Particle groups are now applied also to weathering / decontamination and countermeasures.

Tests that have been performed showed that the new particles deposition schemes behave as expected. The differences in comparison to results with previous deposition schemes justify their implementation.

Two approaches of source term estimation (or ‘source inversion’ - SI) algorithms – based on measurements and atmospheric dispersion models were developed within PREPARE:

- A simple and fast technique that uses very simple dispersion modelling and gamma dose rate measurements in the near vicinity (e.g., at the fence) of a NPP, to estimate total releases of different nuclides.
- A more advanced technique that uses more detailed dispersion modelling and gamma dose rate or other measurements also at farther distances from the NPP (from 1 to 1000 km) to estimate time-dependent source rates of different nuclides at unknown height.

The algorithm for the simple and fast source term estimation has been implemented as a sequential algorithm operating in cycles of specified time length, during which new meteorological and gamma dose rate measurement data become available and retrieved from the database. The source rate calculated for the specific interval is returned to JRODOS and stored in Projects database. The results of the SI project are available for use by subsequent runs of the Local Scale Model Chain (LSMC) of JRODOS. Tests have been performed with the monitoring configuration around Temelin.

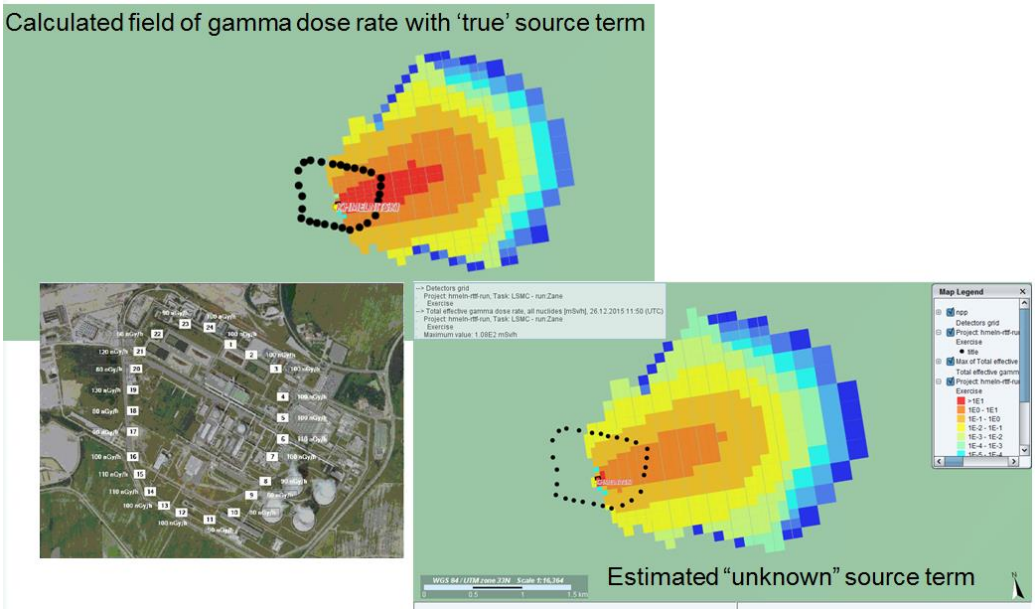

Figure 4: Source term estimation with the simple approach

The SI module based on more advanced techniques is triggered upon user's request and the user can set a few basic parameters that influence its results (such as first-guess source term, time discretization of analysed source term, method for errors' calculation, method for handling multiple nuclides, options related to estimation of release height, etc.). Measurements covering the calculation time period are extracted from the database and concern instantaneous gamma dose rates, nuclide-specific instantaneous and/or time integrated concentration measurements, total deposition and wet deposition. As results, the SI module stores in the system database the source-receptor matrix and the time- and height- dependant analysed source term. The user has the possibility to start an LSMC run using the results of the SI module run. The SI module consists of four sub-modules: (a) steering, (b) SRM calculation, (c) data processing (filtering) and (d) minimization.

The algorithm uses the variational approach to the problem of source term estimation in which the cost function characterizing the difference of simulated results and measurements is minimized with respect to time-dependent release rates of different nuclides. The source receptor matrix (SRM) is calculated during a forward run of the atmospheric dispersion model DIPCOT characterizing sensitivity of calculated values (air concentrations, deposition, gamma dose rates) at points of measurements to values of nuclide emission rates. With the calculated SRM, the problem of source term estimation becomes a linear regression problem. Prior information about source term, the so-called first guess source term, is used to regularize the linear regression problem and to assure uniqueness of the solution.

The issue of unknown nuclide composition of the release is handled using the newly proposed approach of augmenting the SRM and measurement vector with relationships characterizing the ratios of release rates of different nuclides which are calculated on the basis of information available in first guess source term.

The parameters of the regression problem include error variances of the first-guess source term, error variances of observations, of simulated results and of nuclide ratios used in augmented minimization problem. Parameterizations for the above-mentioned error variances are proposed based on literature review and physical considerations.

Testing of the developed source inversion algorithm has been performed using artificially generated 'measurements' (i.e. model-calculated values with true source term) obtained for the meteorological and geographical conditions of the well-known ETEX experiment. Robustness and real-time applicability of the developed algorithm has been demonstrated.

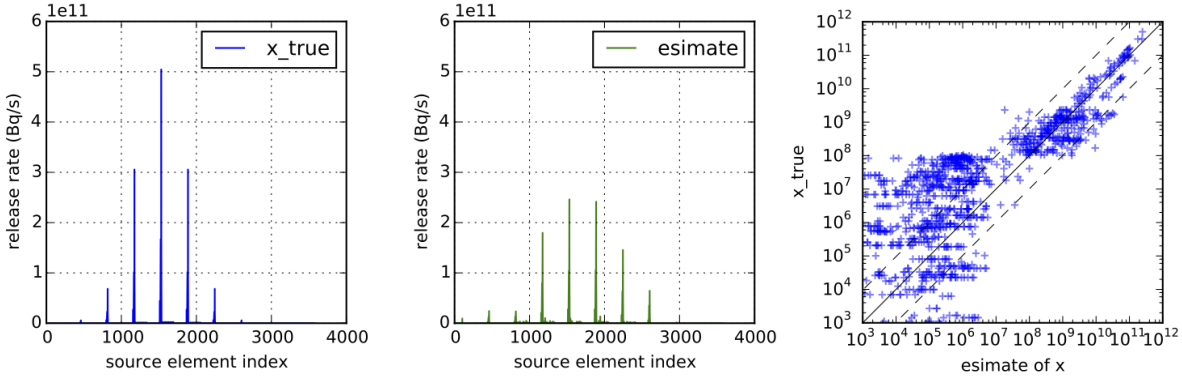

Figure 5: Comparison of "true" and "estimated" ETEX source strength with the advanced approach

As an additional task, the computational speed of the advanced particle models in ARGOS and RODOS was improved which became necessary for long-lasting source terms.

3.3.2 Aquatic modelling

The objective in the aquatic modelling area was to extend the Hydrological Dispersion Module of RODOS (RODOS-HDM). So far the HDM was mainly designed as a tool for the prediction of short-term transport and dispersion of radionuclide in river systems. The following new functionalities were added

- Modelling of radionuclide transport in coastal waters driven by the atmospheric fallout from the dispersion module of RODOS and/or by direct releases into the marine environment. This approach can be used for the real-time forecasting and for the analyses of long term contamination of the marine environment including marine biota.
- Modelling of the long-term behaviour of radionuclides in freshwater systems for predicting radiation doses via aquatic exposure pathways and analysing the efficiency of countermeasures to reduce the burden to the public.

In addition, the modules of the HDM should be validated with data from the water bodies of the Fukushima Prefecture including first assessments of the efficiency of countermeasures that might be appropriate in that area.

The final chain of transport, dispersion and dose models can be seen in the following figure.

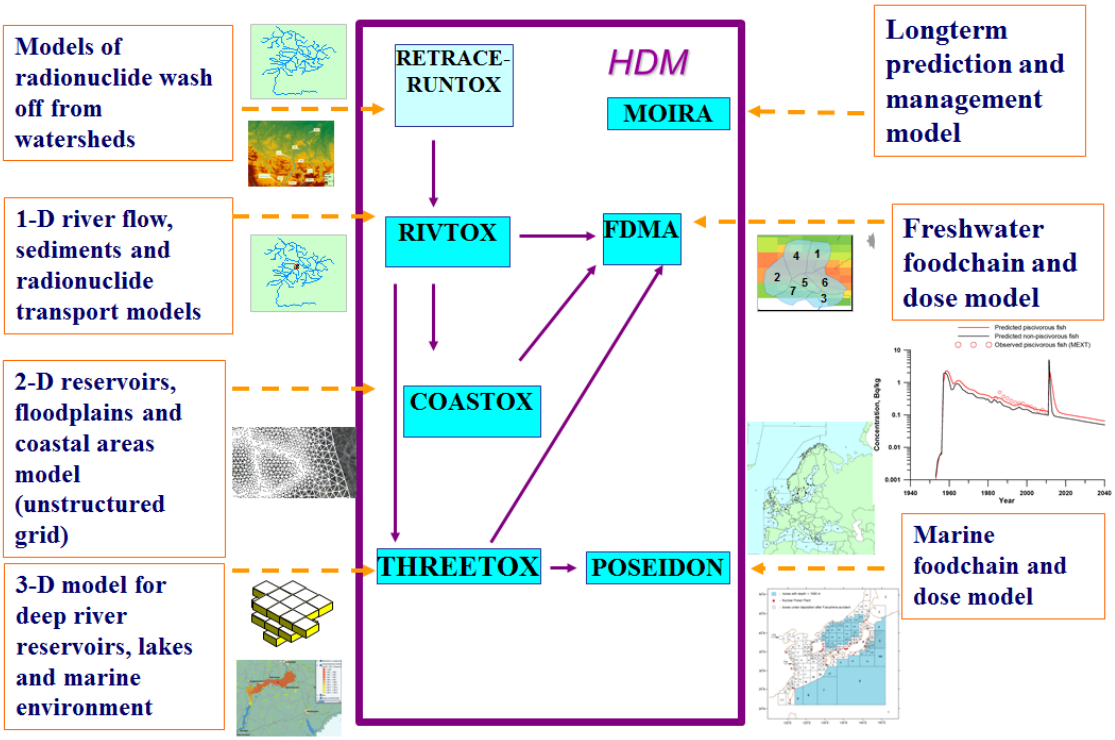

Figure 6: Hydrological model chain (HDM) of RODOS

The 1-D hydraulic model RIVTOX was improved in tis computational scheme. The new version is now based on the full Saint-Venant equation allowing to simulate also complicated river networks (instead of diffusive wave approximation). In addition, a new sediment- radionuclide transport model was added.

The 3-D model THREETOX which is designed for the application in coastal areas or complex and deep lakes was improved with respect to the modelling of the behaviour of radionuclides in sediments. Here a two-step kinetic was implemented allowing to consider short-term and long-term behaviour of radionuclides in the sediments (see **Figure 7**)

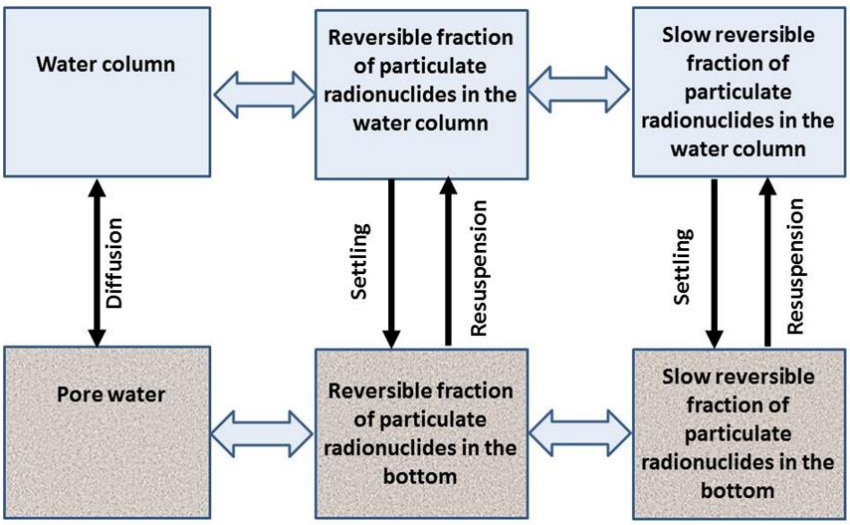

Figure 7: Improved modelling of sediments in THREETOX

In addition, the global simulation model MyOcean (http://marine.copernicus.eu/web/2-about-your-copernicus-marine-service.php) can be now used as a boundary condition for the simulation model. This is important, as THREETOX requires a driving force outside its simulation area. Using results from MYOcean, it is now possible to customise THREETOX for any area in the world. Several validation studies were performed with THREETOX. One example, related to a direct release of radionuclides into the ocean, can be seen in the following figure. The agreement between monitoring points (dots) and the simulation (line) is reasonable good.

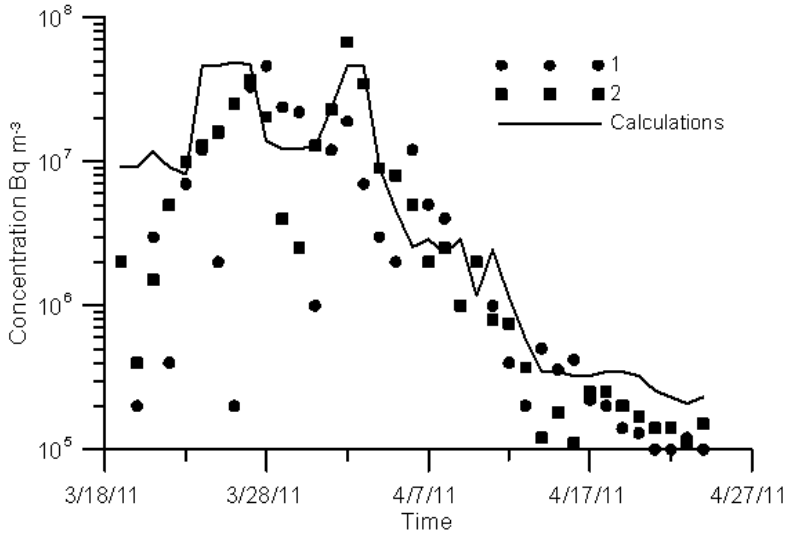

Figure 8: Time series of observed and simulated seawater surface ^{137}Cs concentrations at TEPCO (2011) stations T-1 and T-2

MOIRA is a decision support system for characterising the radiological situation and selecting adequate management strategies for different aquatic ecosystems contaminated by radionuclides. It is intended to be used for longer-term problems and focuses on caesium and strontium contamination. The system has been validated and was available as stand-alone version. As MOIRA covers an area which was so far not part of the RODOS HDM, the decision was taken to integrate the stand-alone version fully into the HDM system of RODOS. This allows now to simulate the longer term behaviour of radionuclides in river catchments and the definition of appropriate countermeasures. An example for a Spanish catchment can be seen in **Figure 9**.

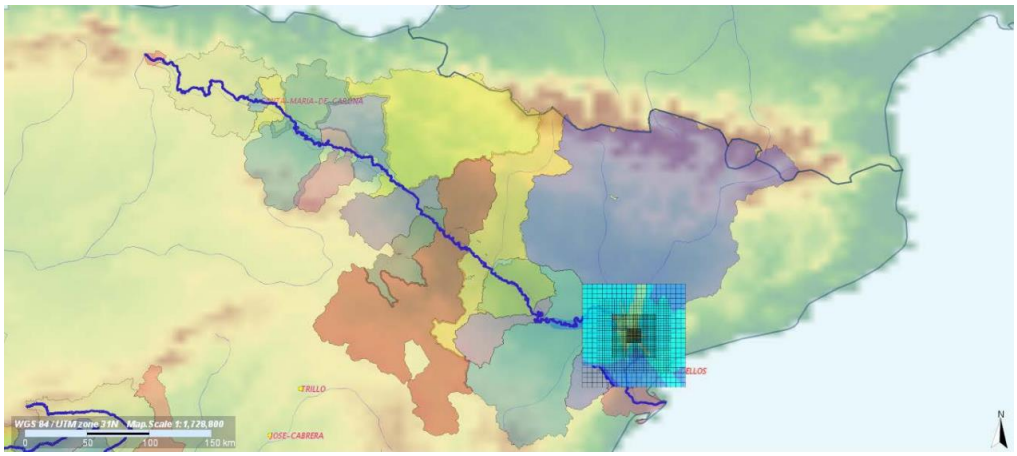

Figure 9: Test of MOIRA in Spain based on a release from the Ascó NPP

The box model POSEIDON, designed for the application in lakes, reservoirs and the marine environment, was extended in its foodchain modelling by adding benthic organisms to describe the migration of radionuclides from contaminated bottom sediments to marine organisms in the food web. This allows a much better applicability to the marine environment.

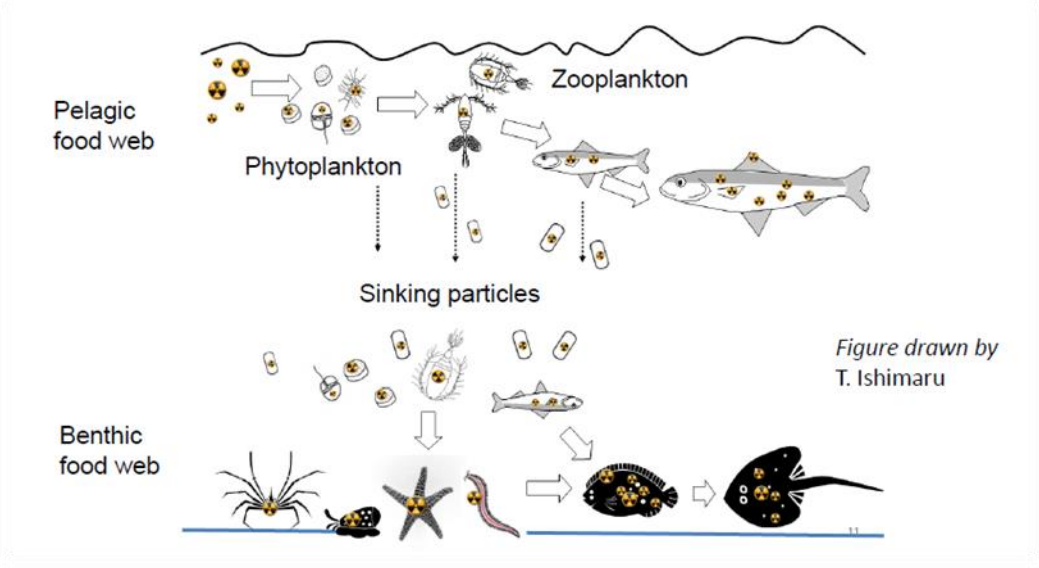

Figure 10: Radionuclide transfer in pelagic and benthic food webs as implemented in POSEIDON

The new foodchain approach of POSEIDON was applied to the marine environment around Fukushima. **Figure 11** clearly demonstrates the performance of the new modelling.

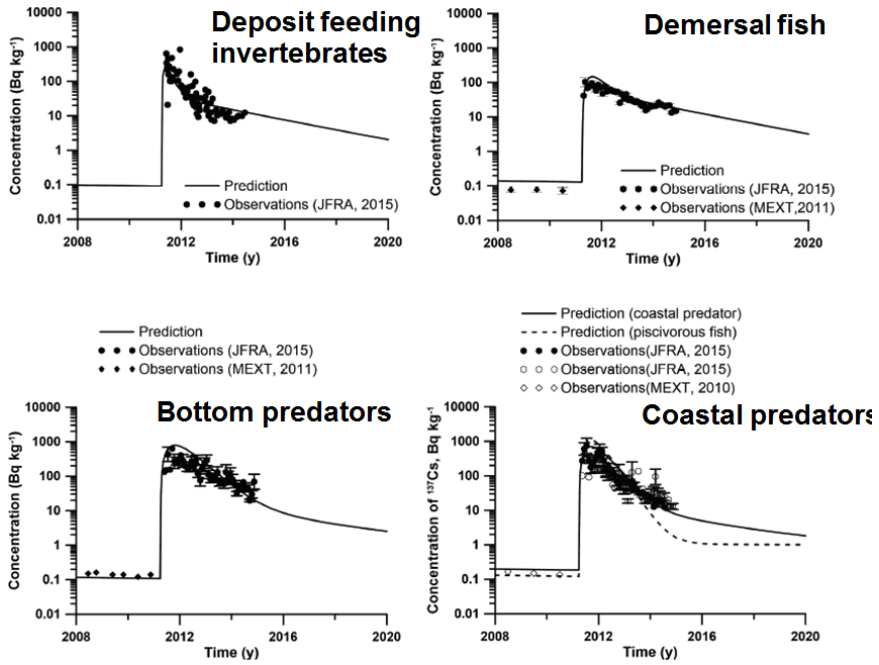

Figure 11: Comparison of POSEIDON simulations with measurements

3.4 Communication with the public

Not to lose trust is one of the key objectives of authorities in the aftermath of any disaster. Fukushima as well as Chernobyl demonstrated, that this is difficult to achieve. Therefore we investigated the conditions and means for pertinent, reliable and trustworthy information to be made available to the public in due time and according to its needs in the course of nuclear emergency and post-emergency contexts. The work should be based on the experience made in Japan and Europe following the Fukushima disaster, taking into account the complexity and dynamic dimensions of the information flow.

The complexity of actors and information flow can be seen in

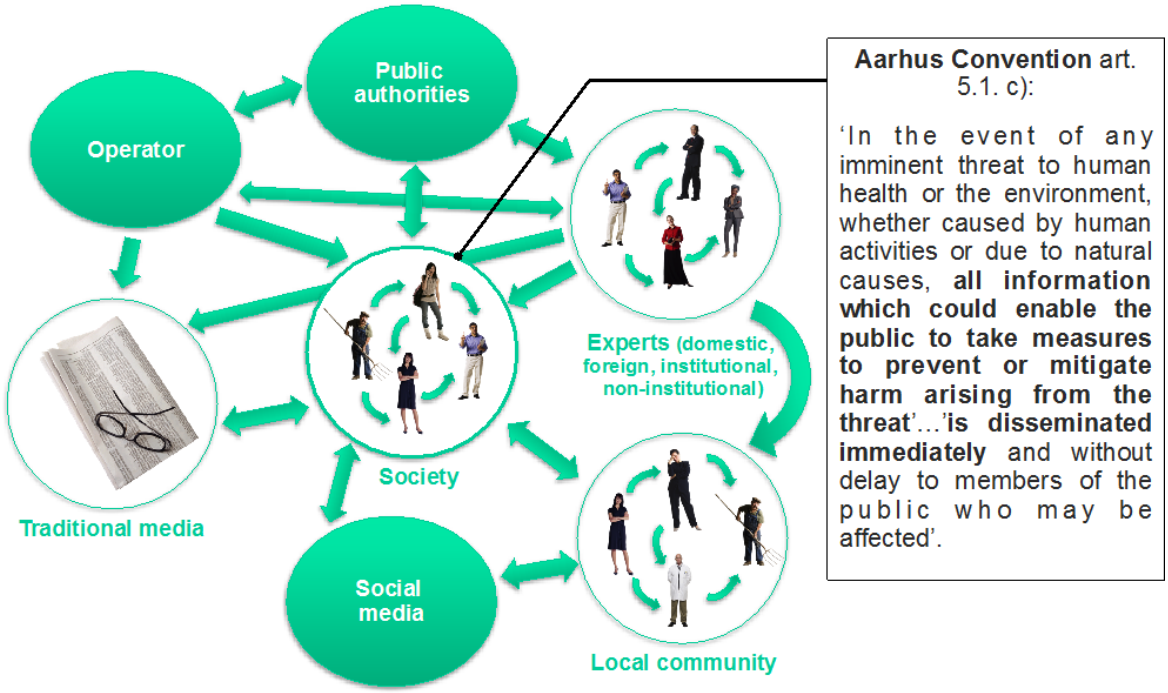

Figure 12: Information flow between the various actors

Important in this respect is the question: How can the plurality of actors and of information flow contribute to the emergence of a situation where people can make their own opinion in a robust way? Important to the answer is also the role of social and traditional media in the information management and how experts can best interact with both.

In a first activity, information has been collected how experts and local actors experienced the Fukushima disaster. As a result the following findings became obvious for the local population

- Local populations face the maximum level of complexity as their day-to-day life is disrupted
- Local populations are confronted to dilemmas: evacuating or living in a contaminated environment; both drastically disrupt the daily life and is source of stress
- Societies and institutions cannot be prepared in the usual meaning of preparedness, reserving resources and setting up routines, and procedures that can temporarily

replace jeopardised systems of decision and action in order to facilitate a return to normality

- In a context of spreading of distrust, local population have to recreate the conditions by their own to access trustworthy and reliable information, understand the situation at the individual and community level and support reliable decision making at the individual and community level
- Social processes of recovery cannot be decreed but can be facilitated (or hindered) by various actors like public authorities, experts, NGOs, foreign institutions
- Post-accident policies should focus on supporting local people and local communities that engage in rebuilding a life that is worth living

For professional experts, the situation is also complex as they have to deal with uncertainties and multi-dimensional issues that might be beyond their expertise fields. The role of experts, however, is not purely technical but also social as they are confronted by a diversity of interactions with other experts (inside and outside institutions), with authorities, local populations and the media. To analyse the situation with (in the role of an expert? As an expert?) the role of the experts, interviews were made with professional experts and also experts which (with?) acknowledge expertise by local communities.

One of the key elements which have been investigated in these interviews was the question of trust and how trust can be established. It was acknowledged, that nuclear power has never been a value-neutral technology and the role of experts in managing nuclear emergency and post-emergency situations depends strongly on the level of trust of the society. It was also concluded, that trustworthiness of information is not the level of trust of one actor towards a given source, but the result of the interactions between the different experts and information providers. In this respect the acceptance of an expert by the society is the key for building the condition to disseminated trustworthy information. On the other hand, the expert has also the responsibility to deal with the complexity of a nuclear emergency and post-emergency situation in a way that fits the complexity of societal needs.

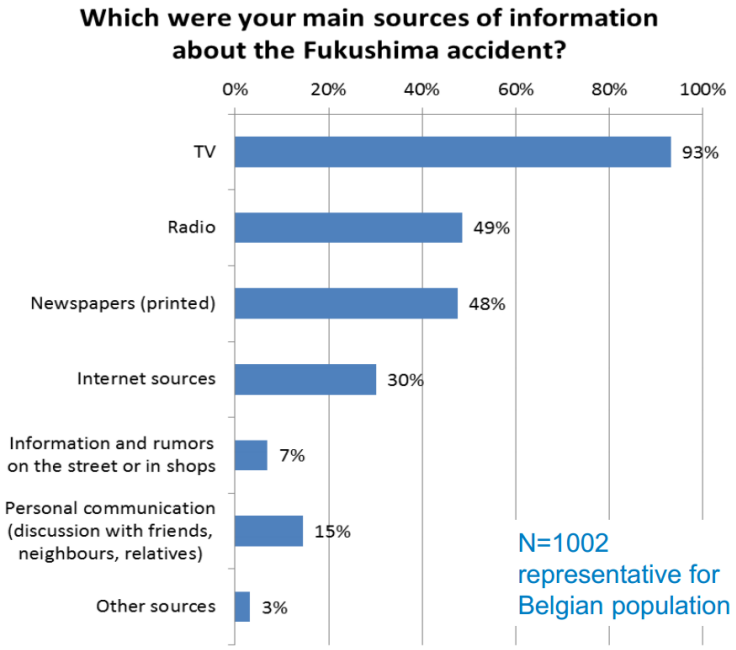

Figure 13: Main sources of information following Fukushima

Looking at the role of the mass media, a survey in Belgium clearly showed the domination of the traditional media as source of information. The main sources of information there are the internet, online issues of newspapers, radio and TV. When looking at the internet sources, online issues of newspapers and radio and TV were here the main sources of information. However, also web pages of the government and Facebook were used frequently. For example the Facebook account of the IAEA was called about 2000 times before and more than 18000 times in the early stage of the Fukushima disaster. Communication with mass media during and after a nuclear emergency presents both a challenge and an opportunity for emergency management. The challenge lies in the different motivations and types of processes applied by mass media and emergency management. The opportunity arises from the power of mass media to reach an audience with information important for compliance with protective actions. Results show that although challenging, nuclear emergency communication can be improved by using mass media and developing skills, training and resources during the preparedness phase of a nuclear emergency cycle.

Mass media communication is a challenge for emergency management organisations since communication has evolved into a multiple-way process where information is disseminated at an, often, uncoordinated incredibly rapid pace. Social media has given to all users a virtual platform to express themselves and to share information. An overload of (mis-) information coming from all kinds of sources (e.g. government, expert organisations, traditional media, individuals, inhabitants, NGOs etc.) can make it difficult for people to differentiate which information is correct.

One can clearly conclude that today mass media can intensify or downplay a nuclear risk and they allow rapid dialogue among users and public engagement. Therefore, implementation of media communication in the emergency management plan requires clear recommendations, practical advice as well as an experienced and dedicated team to be successful. Some general recommendations have been derived and documented in the project report.

As the Analytical Platform was identified as a potential tool for information gathering and sharing and thus could be used to interact with mass media, a survey based on interviews was carried out to investigate the conditions for trustworthy and reliable engagement of institutional and non-institutional experts in the Analytical Platform. Interviewees included PREPARE members, institutional experts, regulators, NGO experts and international institutions (OECD-NEA, ETSON, HERCA).

According to the interviewees, the Analytical Platform is more likely to be used by experts in the case of a more distant accident, or after the emergency phase. In the emergency phase of a domestic accident (or an accident close to national borders), both institutional experts have a responsibility in emergency and immediate post-emergency management. NGOs and independent experts will be already heavily solicited and will have little resources to dedicate to the Analytical Platform.

However, the Analytical Platform was identified as a tool to constitute a valuable pool of expertise for authorities but also non-institutional experts. The “Ask the expert” tool of the platform, dedicated to a two-ways communication with the public, enables experts to

adapt information provision to the actual needs of the public and better answer the questions posed by the media.

Participation of experts in the platform necessitates well defined conditions for safe and reliable engagement in the PREPARE analytical platform. Among them are

- Clear terms of reference, rules of operation and code of conduct and governance rules;
- Clear identification of the experts taking part in the platform;
- Exchanges within the Analytical Platform should avoid political discussions and be safe from manipulation;
- Limitation of the additional workload for users associated to the participation in the platform;
- Explicit rules for information sharing and confidentiality in expert-to-expert exchanges, including notably a reliability score (from very speculative to confirmed) associated to the different pieces of information shared within the platform and a clear system of dissemination level, from public to confidential;
- Proper identification of the source of the different pieces of information.

This analysis was helpful to develop the operational procedures of the Analytical Platform. It concluded, that the Analytical Platform has a potential in facilitating the information exchange between experts, NGOs, the public and mass media at the European level. However, the conditions of use have to be clearly defined and tests performed in the near future.

3.5 Analytical Platform

The general idea of the AP is to provide an easy to access platform for information exchange in times of a nuclear or radiological crisis, allowing discussions between experts and to disseminate information to the public community. If an alert is issued based on a protocol to be developed as part of the operational procedures, members of different organizations would be attached to the platform and start working. The following flowchart represents the key components and the work flow of the AP

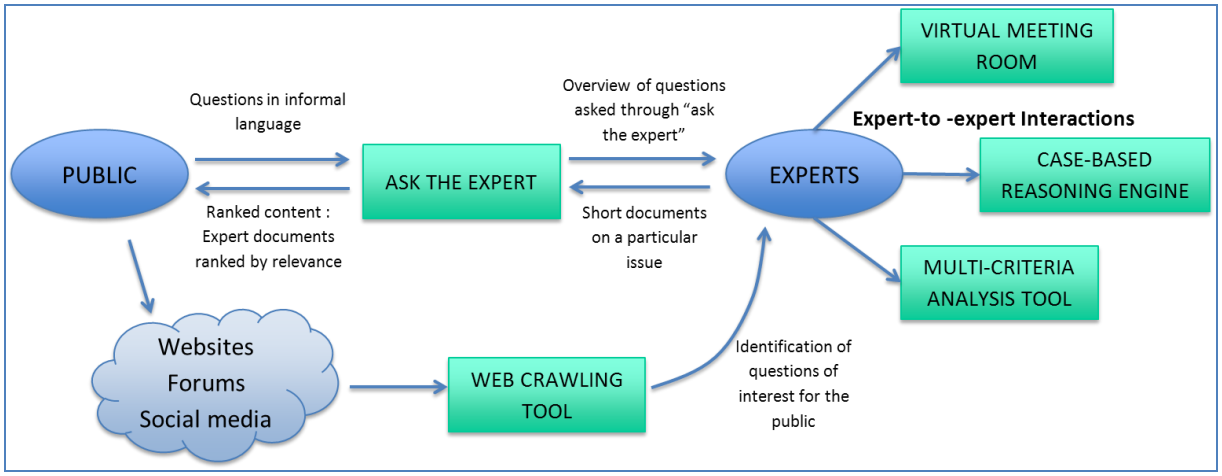

Figure 14. Analytical Platform with its components and work flow

The core of the AP is the knowledge database with historic events and scenarios and its Case Based Reasoning (CBR) algorithm to compare them with the on-going event. The CBR methodology is a process to identify that scenario which fits best to the one under investigation. To facilitate the retrieval mechanism, appropriate similarity functions had to be developed to compare the on-going event and the one from the knowledge data base (Figure 15). Uncertainty handling is important for any complex natural or man-made disaster. Therefore also a concept for dealing with uncertain information was defined.

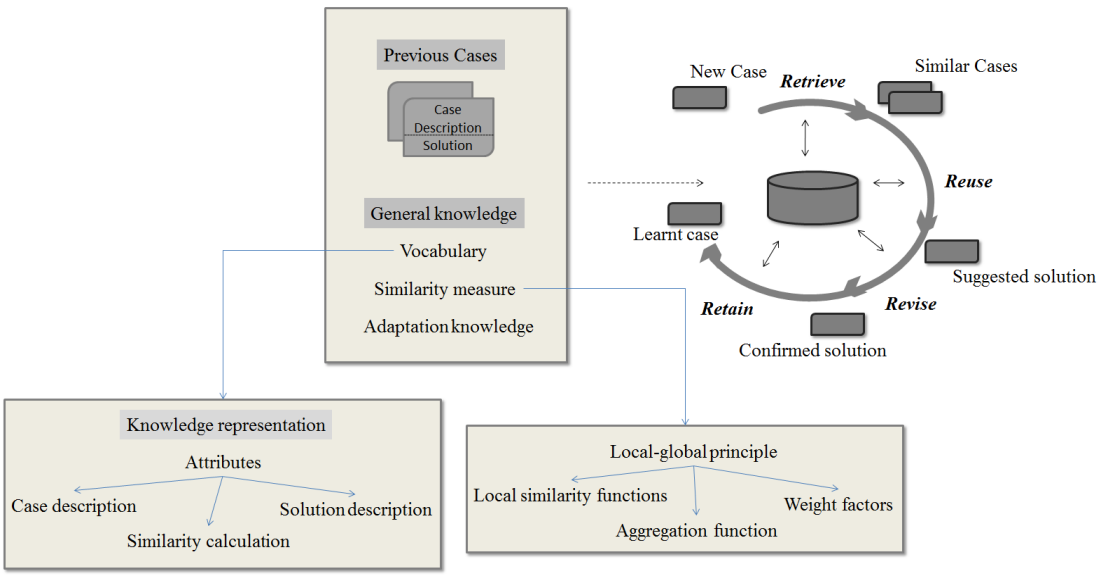

Figure 15: CBR cycle and knowledge included in the system

16 historic cases from Windscale fire, Chernobyl and Fukushima accidents and the poisoning of Alexander Litvinenko have been integrated into the data base. These cases are shown in Figure 16. As the number of historic cases was small, additional 96 scenarios have been added to the database. In addition, the new HERCA-WENRA scheme was adopted for the pre-release phase. It proposes a methodology for a common European approach allowing to recommend urgent protective actions as well as a minimum common level of preparation for these actions:

- evacuation should be prepared up to 5 km around nuclear power plants, and sheltering and Iodine Thyroid Blocking (ITB) up to 20 km
- a general strategy should be defined in order to be able to extend evacuation up to 20 km and sheltering and ITB up to 100 km

The parameters affecting the result are the following and are not used in the AP

- risk of a core melt
- integrity of the containment
- wind direction known
- evacuation can be performed in time or not

Phase / Event	Chernobyl nuclear power plant accident	Fukushima Daiichi nuclear power plant accident	Windscale fire	Poisoning of Alexander Litvinenko
Release	3	1	1	1
Transition	1	-	1	1
Long-term post-accident	4	1	1	1

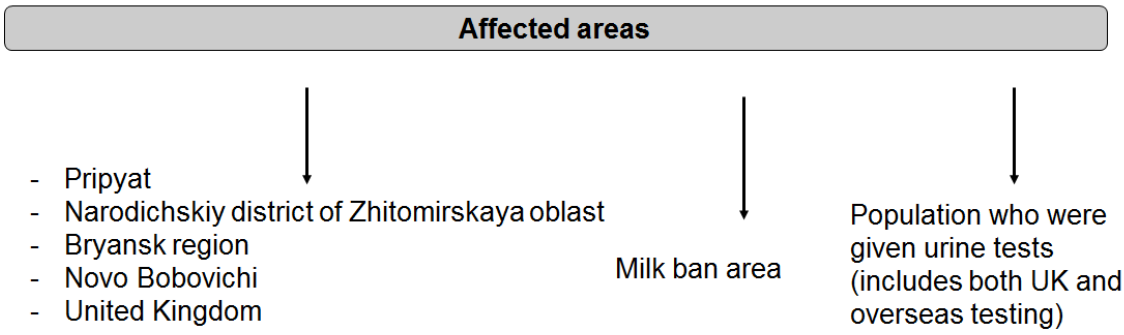

Figure 16 Number of historic cases implemented into the knowledge data base

For the release phase, 4 key parameters were identified to define 96 scenarios:

- INES scale – sourceterm (5, 6, 7)
- Season of the year (spring, summer, autumn, winter)
- Weather (with rain, dry, low wind speed, medium wind speed)
- Population distribution (urban, rural)

In the longer term, only one weather condition and the population distribution were taken into account for the scenario construction. The values were normalised to a certain contamination level (100 mSv in the first year) and the area of one square kilometre. This allows for scaling to other conditions. Having used the scenarios as defined for the early

phase, the dose distribution would be too inhomogeneous to define measures in a proper way. So far 8 scenarios have been implemented – more will be defined within the European project HARMONE.

Further important tools of the AP are the "*Ask the Expert*" service and the "web crawling" facilities. Both tools are based on the *NOMAD Web Crawling Platform* developed by NCSR-D in the context of FP7-ICT NOMAD.[1]. The following components were developed:

- The *NOMAD Web Crawling Platform* provides the underlying crawling functionality. The NOMAD Platform persists crawling results in a MySQL database. The Nomad Platform is a Tomcat Web Service controlled via a REST API.
- The PREPARE *Web Content Discovery Service* acquires and sifts through public on-line forums in order to categorize content according to its relevance to several sub-categories of the overall nuclear and radiological events theme. This service executes on a Liferay portal and provides a user interface for controlling the Crawling Platform as well as the functionality for using Cron to periodically repeat crawls along with the functionality for extracting and displaying statistics about the terms that occur in the crawled documents.
- The *PREPARE Ask the Expert Service* provides functionality for managing and retrieving documents, including functionality for recommending documents based on their relevance to user query terms.

The Bing™ search engine, the Google+™ social network and the Twitter™ social network can be scanned. The user can define particular search queries and can run them for a short or longer term. In particular for longer term queries, a statistics will be provided that shows the importance of the expression in the longer term development. This allows to react on an emerging topic which is at present not realised as relevant.

The *Ask the Expert Service* comprises a document management. The user can upload documents, annotate them with terms, or update documents with new versions. The documents in the collection can be searched using a full-text index of all the terms appearing in them or for the user-provided annotation terms. This panel is based on the standard Liferay Documents and Media Library as part of the AP.

The AP was realized as a portal and based on Liferay as content management system. Liferay organizes the content in Sites, Site templates, Pages, and Page templates (Figure 17).

The first draft of the AP has been tested in several countries and finally implemented for a training course in September 2015 in Trnava. The final version was demonstrated in Bratislava at the final dissemination meeting.

[1] For more details, please cf. http://www.nomad-project.eu

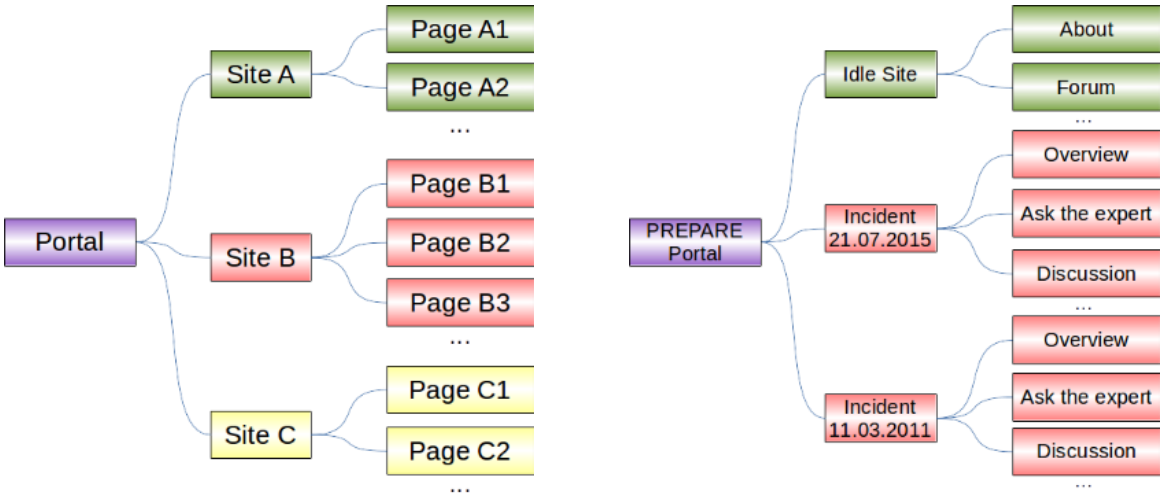

Figure 17: The left side shows the Liferay portal structure in general, containing different sites, each site providing different pages. On the right side the actual organization of sites and pages in the PREPARE Portal is shown.

To explore the usability of the AP, a web survey was initiated and 73 members of the NERIS Platform and the PREPARE project have been contacted. 32 completed the questionnaire. Some of the answers are listed here exemplarily

- Useful tool mainly for experts (50% respondents) and in a lesser degree for the public (32%)
- More trustworthy tool for experts (47%) than for general public (29%)
- The experts are willing (47%) or very willing (28%) to share information with the public, with a 22% moderately in favour
- Most respondents (78%) are interested in sharing information with others

One of the important conclusions was that data sharing and rules for information sharing is the key in the acceptance of the new tool.

4 The potential impact

4.1 General Impact

The Fukushima disaster, even 10000 kilometres far from Europe, has affected Europe in many different areas. Mass media, the public and politicians have asked for assessments of that event and if there might be consequences for Europe. In particular at the early stage of the event, the following deficits in Europe could be seen:

- Missing information about the potential source term
- No coordination on the European level to estimate a source term
- No harmonised response in the European Member States related to their residents living in Japan
- Partly chaotic communication with the public in several European member states
- No clear guidance how to deal with incoming goods, in particular food products, but also industrial products

PREPARE has reduced these gaps identified by providing the technical means for a better harmonised response in Europe. This was achieved by fostering the analytic skills at a European level and providing a better guidance how to communicate with the public and all affected stakeholders. The project has also analysed the existing procedures in emergency management, cross border monitoring and dealing with contaminated goods. Furthermore, tools applied in emergency management and rehabilitation preparedness such as the decision systems ARGOS and RODOS have been significantly improved by developing methods and tools to better estimate a source term in the early phase of an emergency and improving terrestrial and aquatic simulation models. Having the NERIS Platform and the ARGOS and RODOS users groups involved in the project, the European dimension was clearly addressed.

4.2 Societal impact

Closing gaps in the current emergency management procedures as well as in the longer term rehabilitation practices will clearly improve the acceptance of measures of the acting organisations. Of particular importance for public trust is the adequate information of on-going evolutions of the emergency and their possible consequences. This was achieved by the development of the Analytic Information Platform which collects information from open sources and provides the expert with access to historic cases which may help in the evaluation of the current one. Such an unbiased source of information, in particular when realised as a European wide and independent service, will assure the public that information is spread in the best possible way. Disruption of the daily life will also be reduced with the advanced communication procedures that were developed, considering state of the art Internet technologies and social media. Both aspects will help in keeping confidence in authorities and their decisions taken.

As the governmental organisations responding to the emergency have improved decision support systems and therefore apply the newest state-of-the-art approaches and tools that are available, this will surely build trust and confidence in the public

4.3 Economic impact

The Fukushima disaster clearly demonstrated again that the economic effects of a nuclear or radiological emergency cannot be underestimated. Besides the local effects in the national economy, in particular neighbouring countries will tend to not import products from the affected country. Even far away, consequences for products exported from the accident country are dramatic, even if the radiological impact is negligible. Therefore, fast and comprehensive information on the real contamination is important to avoid overreaction inside and outside the country. The results from PREPARE will support the preparation and thus the optimisation of resources (i.e. expenditure) for decontamination and health care and supports a faster restoration to normal living conditions. This will enhance the public confidence and feeling of security to return to normal economic (business) activities.

4.4 European dimension

The European dimensions can be seen in various areas. The large number of organisations participating in PREPARE and the direct link to the NERIS Platform on nuclear and radiological emergency and post-accident preparedness and management assures the outreach at a European level. The improved methods and tools will be distributed throughout Europe on the one side via the two decision support systems ARGOS and RODOS and on the other side via training courses and a dissemination workshop.

4.5 Dissemination activities

Dissemination has been realised at various levels. The more than 50 NERIS Platform members have been informed about the progress of PREPARE in each of the yearly meetings as well as via articles in the NERIS newsletters which were issued several times per year. A second pathway for dissemination of the results was the implementation of the new methods and simulation software into the two European decision support systems ARGOS and RODOS. All simulation tools will become available in the next releases of both software systems.

The NERIS Platform organised a workshop on the 27-29 April 2015, Milano (Italy) where the current research activities and the need for further research was discussed. The Workshop gathered 68 participants and 37 papers dedicated to the 3 research areas of the NERIS Strategic Research Agenda and the implementation of BSS on emergency and recovery issues were presented. Among them, many papers related to the PREPARE project were part of the 6 sessions

- Session 1: Challenges in atmospheric and aquatic modelling
- Session 2: Improvement of existing decision support systems
- Session 3: Improvement of the decision-making-processes and the implementation of the Basic Safety Standards
- Session 4: Stakeholder engagement and dialogue
- Session 5: Information and social media
- Session 6: Research coordination and round table discussion

As a results one could conclude, that PREPARE research activities touched several research priorities defined within the SRA of the NERIS Platform. This clearly indicated the importance of the PREPARE project and the interaction with the platform.

The PREPARE Dissemination workshop "Innovative integrative tools and platforms" was organized jointly with the VUJE AS and Science and Technical Society (VTS) at VUJE in close cooperation with the PREPARE project contractor and NERIS Platform Management Board and Secretariat as part of WP7.2.3. The dissemination workshop was held at Park Inn Danube Hotel, Rybne nam 1, Bratislava, Slovak Republic in January, 20-22, 2016. All in all 112 participants participated at the workshop representing twenty-four countries. Participants came from Austria, Belarus, Belgium, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Ireland, Japan, The Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine and United Kingdom. The workshop language was English. There was no registration fee charged for attendance. Participants covered their own travel and subsistence costs.

The PREPARE dissemination workshop allowed to present the results of the PREPARE project and to collect feedback from the participants on the topics of potential future research activities. The knowledge acquired during the project has been disseminated as well as the capability of the new methods and tools in particular those of the Analytical Platform for collecting information, analysing any nuclear or radiological event and provide information about the consequences and its future development. Plenary sessions and demonstrations have been organized under the following structure:

- Review and investigation of the operational arrangements and procedures (emergency preparedness for long lasting releases and management of consumer goods);
- Enhancing of the existing decision support systems with capabilities of importance (estimation of the source term, atmospheric and aquatic dispersion and consequence modelling);
- Improved means for the interaction of technical experts with authorities in charge, communication from and to the public and the training of key players;
- Unique Analytical Platform of European dimension being a focal point for collecting information, analysing any nuclear or radiological event and providing information about the consequences which supports experts in evaluating an on-going event;
- Integrative tools and platforms and their role within the common road map on radiation research in perspective of European research programme Horizon 2020.

The common road map on radiation research has been presented at the last day of the workshop and a panel discussion with European and International organisations, such as IAEA, ICRP, OECD/NEA, HERCA underlined and focused attention on possible new and requested research activities. A plenary discussion session on "the way forward" concluded the PREPARE Dissemination workshop.

All presentations of the PREPARE Dissemination Workshop will be published in the form of articles in a Special Issue of Radioprotection - the Journal of the French Society of Radiation Protection.

Further to these workshops, scientific papers have been submitted and presented, to be mentioned here in particular the regional European IRPA conference in June 2014 and the international IRPA scheduled for May 2016.

4.6 Exploitation of results

Two basic courses on emergency management and rehabilitation have been prepared and conducted. The first course focused on the early to intermediate phases after a nuclear/radiological accident, whereas the second course was related to the long term management of contaminated territories. Both courses were harmonized to cover all important aspects, with minimum overlap. They were organized in close collaboration with European actors participating in the NERIS platform.

The early/medium phase course was organized in Mol, Belgium, on March 17-21, 2014, the course related to the long term management of contaminated territories from March 16-20, 2015. Both courses were fully booked. The first course enjoyed participation from 14 countries. The 31 participants belonged to regulatory authorities, technical support organizations, research institutes, first responders and other actors involved in emergency management. In the second course the limit was set to 20 people to keep it efficient. The core of the course consisted of lectures on radiological evaluations; principles of intervention; planning and organisation in off-site emergency response; factors influencing decisions; decision support tools; European and international agreements and legislation; crisis communication and stakeholder involvement. Two exercise sessions were organised during the course, one focusing on radiological assessments and being supported by the decision support system JRODOS, the other a more extensive table-top exercise with a simulated accident scenario. The Fukushima accident was a transversal theme, addressed in several of the lectures: atmospheric dispersion, international recommendations and regulations for the protection of the public, transfer to the food chain, communication and others. A detailed course evaluation was organized on organizational aspects and aspects related to the content (clearness, usefulness) of the course according to the SCK•CEN Academy standards. The course was highly appreciated by all participants.

The "Late Phase Nuclear Accident Preparedness and Management" course was organised by CEPN, France and the Institute of Radiology, Belarus in collaboration with NERIS from 15 till 19 September 2014 in Gomel, Belarus. This collaboration between CEPN and the Institute of Radiology (RIR) allowed a unique visit of participants to the contaminated territories and learning from meeting the local people engaged in the rehabilitation of living conditions. This included also visits to local centres for developing a practical radiological protection culture. Apart from these visits the course addressed: the elements at stake in the long term based on feedback experience from the post-Chernobyl situation in Belarus and Norway, the ICRP perspective (ICRP 111) and the post-Fukushima situation; the management of food production systems : chronic ingestion, European regulation, feedback experience from the Chernobyl and Fukushima accident, interpretation of whole body measurements and the EURANOS food handbook; state of health and life conditions in contaminated territories and long term preparedness and stakeholder involvement. Experts from France (CEPN, IRSN), Belarus (RIR), Japan (University of Tokyo), Norway (NRPA) and Ireland (RPII) gave the training. An evaluation of the course was done by trainees and trainers.

In addition, two table-top exercises were organized dealing with a transport accident and with monitoring of a large scale cross border contamination, respectively.

A training course “Analytical Platform – scientific methods and tools for information collection and exchange” has been developed providing the necessary information on the

Analytic Platform, the scientific methods and tools developed for collecting information, analysing any nuclear or radiological event and providing information about the consequences and its future development. The main objective was to train participants to use the new tools for the purpose of further active participation in exercises (INEX5) and the use of the new or updated tools within the Analytic and NERIS Platform.

The training course was organised by KIT (Germany), NCSRD (Greece), CIEMAT (Spain), VUJE (Slovak Republic), SCK•CEN (Belgium) and Mutadis (France) in cooperation with the European platform NERIS on emergency and post-accident preparedness and response. The training course was hosted by VUJE, Okruzna 5, 918 64 Trnava, Slovak Republic and Science and Technical Society (VTS) at VUJE in October, 7-9, 2015.

All participants were satisfied with the course facilities, design, programme and conduct. All lectures were well received. The demonstrations and training practical sessions were very much appreciated and well received by participants. Besides the printed course folder, all participants received a memory stick with the whole training course materials in electronic form.

5 Public website address and contact details

PREPARE public web page: http://www.prepare-eu.org/index.php

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1 (Coordinator)	Karlsruhe Institute of Technology	Germany
2	Centre d'étude sur l'Evaluation de la Protection dans le domaine Nucléaire	France
3	Norwegian Radiation Protection Authority	Norway
4	VUJE Inc.	Slovak Republic
5	Radiation and Nuclear Safety Authority of Finland	Finland
6	Universidad Politécnica de Madrid	Spain
7	MUTADIS	France
8	National Centre for Scientific Research “Demokritos”	Greece
9	Technical University of Denmark	Denmark
10	Danish Emergency Management Agency	Denmark
11	Prolog Development Centre	Denmark
12	Health Protection Agency	United Kingdom
13	Norwegian University of Life Sciences	Norway
14	Ukrainian Center of Environmental and Water Projects	Ukraine
15	Bundesamt für Strahlenschutz	Germany
16	Slovenian Nuclear Safety Administration	Slovenia
17	Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas	Spain
18	Belgian Nuclear Research Centre	Belgium
19	Institut de Radioprotection et de Sûreté Nucléaire	France
20	Association of Instituto Superior Técnico for Research and Development	Portugal
21	Jožef Stefan Institute	Slovenia
22	Greek Atomic Energy Commission	Greece
23	Agencia Portuguesa do Ambiente	Portugal
24	National Institute for Public Health and the Environment	The Netherlands
25	Radiological Protection Institute of Ireland	Ireland

26	University of Vienna	Austria
27	Universtiy of Western Macedonia	Greece
28	University of Milan	Italy
29	Nuclear Research & consultancy Group	The Netherlands
30	Liana Papush	Sweden
31	EnerWebWatch/Coopaname	France
32	Eidgenössisches Departement des Innern (EDI)	Switzerland
33	Association pour le Contrôle de la Radioactivité dans l'Ouest	France
34–	University of Ljubljana	Slovenia
35	"Horia Hulubei" National Institute of R&D for Physics and Nuclear Engineering	Romania
36	University of Seville	Spain
37	Agenzia Nazionale per le Nuove Tecnologie, l'Energia e lo Sviluppo Economico Sostenibile	Italy
38	Nuclear Safety Authority (ASN)	France
39	RIKILT – Institute of Food Safety, Wageningen University and Research	The Netherlands
40	Royal Netherlands Meteorological Institute	The Netherlands
41	KWR Water B.V.	The Netherlands
42	Federal Agency for Nuclear Control	Belgium
43	Office for Nuclear Regulation	United Kingdom
44	TN International	France
45	State Scientific and Technical Centre for Nuclear and Radiation Safety	Ukraine
46	PDC-ARGOS APS	Denmark
47	Department of Health	United Kingdom
48	National University Corporation Fukushima University	Japan

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