European Cooperation in the field of Scientific and Technical Research

- COST -

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COST 028/13

MEMORANDUM OF UNDERSTANDING

Subject :	Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action IS1304: Expert Judgment Network: Bridging The Gap Between Scientific Uncertainty And Evidence-Based Decision Making

Delegations will find attached the Memorandum of Understanding for COST Action IS1304 as approved by the COST Committee of Senior Officials (CSO) at its 187th meeting on 15-16 May 2013.

MEMORANDUM OF UNDERSTANDING
For the implementation of a European Concerted Research Action designated as

COST Action IS1304
EXPERT JUDGMENT NETWORK: BRIDGING THE GAP BETWEEN SCIENTIFIC UNCERTAINTY AND EVIDENCE-BASED DECISION MAKING

The Parties to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 4154/11 "Rules and Procedures for Implementing COST Actions", or in any new document amending or replacing it, the contents of which the Parties are fully aware of.

2. The main objective of the Action is to create a multidisciplinary network of scientists and policy makers using structured expert judgement to quantify uncertainty for evidence-based decisions, and hence improve effectiveness in the use of science knowledge by policy makers.

3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 40 million in 2013 prices.

4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.

5. The Memorandum of Understanding will remain in force for a period of 4 years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of Chapter IV of the document referred to in Point 1 above.

A. ABSTRACT AND KEYWORDS

Most governments and the new European Union Chief Scientist support the concept of evidence-based decision-making in policy. However, there is a substantial gap between the science models relevant for cutting-edge research and those required for policy analysis. Science-based models often involve substantial uncertainty which require defensible and timely characterisation. The shortage and cost of timely empirical data inevitably requires scientific expert judgment. How this is best elicited is critical to a decision process, as differences in the robustness of elicitation methods can be substantial. Good examples, pioneered in Europe, do exist in specific areas of science, but generalizing and spreading this good practice into other disciplines is hard. Performed rigorously, expert elicitation and mapping of stakeholders' views are powerful means for obtaining rational and scientifically founded assessments of uncertainty. This Action will utilize the COST framework to stimulate the emergence and spread of high quality evidence-based decision support methods to ensure that scientists can have a stronger influence on policy questions by interacting with policy makers and Chief Scientist offices. By including training for young scientists the Action helps create a new generation of scientists who are confident and able to bridge the gaps between science and policy.

Keywords: Evidence-based decision making, policy making, uncertainty quantification, structured expert elicitation, expert judgment.

B. BACKGROUND

B.1 General background

Uncertainty in scientific knowledge is unavoidable and presents many challenges for those involved in policy and decision making. Many governments have committed themselves to evidence based policy and decision making, but find it difficult to operationalize this when individual scientists are legitimately reporting their views of the limitations and uncertainties in scientific knowledge. Government concern with the presentation of risk to the public and through the media is a real problem, as the presentational aspects may lead to changes of emphasis. Equally, scientists have to understand the ways in which their knowledge – which may be based on modelling or lab-based empirical work – may be only partially relevant to some of the phenomena they are asked to provide opinions on.

The prosecution of seismologists in Italy in October 2012 after the L'Aquila earthquake of 2009

vividly illustrates the potential consequences for scientists of misunderstandings about risks. Unless, at societal level, we are able to find methods that enable scientists to express their true views about uncertainties as well as ways to measure their performance in assessing uncertainty, we will not be able to use those judgements with the assurance that they honest and useful. For society at large, the consequences of forcing experts to make what they regard as conservative assessments, that is, providing judgements they do not believe in because they are concerned about personal liability, would be very detrimental. The truly innovative concept underlying SEJ is that we can calibrate expert performance in quantifying uncertainty, encouraging them to be truthful and measuring their capability.

Much research around expert judgement assessment, expert combination, uncertainty modelling, psychological biases, etc, has been carried out since Kahneman and Tversky's work. However, to have a real impact on European policy making it is important that these methods are tailored for specific contexts, understood by domain specialists and used by decision makers in government. It is important that we make research progress in important open areas such as the elicitation of dependency. Progress in this area can be made by individual researchers, but they need to be more strongly aligned towards important open research questions that will make a difference for scientists and policy makers. A COST Action is the most natural way of generating networks of scientists, decision makers and expert judgement researchers in order to move the theory and application to a new level.

B.2 Current state of knowledge

Risk assessment typically requires the assessment of probability distributions representing the "state of knowledge" about uncertainties on physical and even social phenomena. Ideally such uncertainties are framed through reference to hard statistical data or some set of externally sourced measures. However even in the best cases, such uncertainties can remain significant and may be subject to disagreement between authorities. Structured Expert Judgement (SEJ) aims to treat expert opinion as scientific data subjected to methodological rules for quality, and to capture the diversity of expert views. Aggregation is the act of taking these potentially different expert assessments and obtaining a single, coherent, assessment from them.

The literature sets out both mathematical and behavioural approaches to aggregation, but relatively little emphasis is given to performance of the processes. The famous work of the Kahneman and Tversky school identifies the huge impact of framing, anchoring and other biases in assessments of uncertainty. This demonstrates the need to measure and assess performance, for which some

techniques are available, but also underlines the need to pay attention to the influence of process, procedures and training in influencing outcomes. To be acceptable to public authorities, methods should conform to the principles of reproducibility, accountability, empirical control, neutrality and fairness.

SEJ modelling has been applied by the participants in the Action across a range of economic/societal and scientific/technological areas. Following is a list of some of recent applications performed by the participants of this Action, organised according to the applicable COST domain:

• BMBS: Environmental Risks of Genetically Modified veterinary and human medicines

• ESSEM: Natural hazards assessment & mitigation; Science research policy; Dam safety; Carbon capture & storage; Invasive species; Threatened Australian birds; Populations of Koalas in eastern Australia; Potentially damaging invasive pests & diseases associated with trade (& ISCH); Seismic hazard modelling (&TUD)

• FA: Genotoxiccarcinogens Risk; Livestock health policy; Veterinary policy; Burden of disease (&ISCH)

• ISCH: Bioterror agents; Emerging diseases and zoonoses in public health management; Valuing states of health; Attribution of grant effectiveness; Effectiveness of surgical procedures

• MPNS: Safety of nanotechnology food safety consumer products (&FA); Regulatory decisions on safety of nanotechnology enabled consumer products

• TUD: Operational safety in civil aviation; Uncertainty in conceptual design for aviation

While an impressive range of technical areas have been touched, the methodologies used have not reached a critical mass at which there is large scale adoption. There is lack of consensus amongst researchers about the most appropriate approaches to different types of uncertainty assessment problem, both in terms of processes to be used and in terms of the methods for aggregating different viewpoints. Furthermore a major problem in expert elicitation is the assessment of probabilistic dependencies. Experience of unexpected events in risk managed systems in all areas shows that these are often due to unseen dependencies. Current approaches to dependency assessment are limited to simple dependency parameters such as correlation.

B.3 Reasons for the Action

Although various methods for SEJ modelling are available, to date there is no methodological consensus, and indeed no coordinated discussion. European researchers have pioneered formalised procedures and this substantial world lead should be leveraged. Networking will bring together

European Union and Associated States research teams working on specific topics, allowing them to share information, validate and standardise methodologies, and interact with policy makers and Chief Scientist offices.
Acknowledging that politicians and policy makers find it difficult to deal with scientific uncertainty, this Action includes work on improving communication of scientific and social uncertainties to decision and policy makers. By including training for young scientists the Action creates a new generation of scientists who are confident and able to bridge the gaps between science and policy.
The Action is aimed at both economic/societal needs and scientific/technological advances: Economic needs because there are potential commercial benefits arising from an improved assessment of uncertainties, particularly in insurance but also in other sectors like project management; Societal needs because policy makers need better assessments of uncertainty that take account of diverse expert views; Science and technological advances because scientists themselves will benefit from better ways to assess uncertainty in their domains to communicate to those outside the area.
Concrete outcomes will include outputs of guidelines in using SEJ for policy makers, training for early stage researchers so that they can use the methods to build up their careers, case studies around successful implementation of SEJ methods, and academic papers around the further development of SEJ methods. Most importantly, the Action aims to achieve a step-change in the use of SEJ, by engaging with Chief Scientific Advisors throughout COST countries and with learned societies through ALLEA and EASAC. This will ensure the long term impact of the Action.

B.4 Complementarity with other research programmes

The work carried out in the Action relates to that of the UK NERC on its PURE Programme to develop new methods for quantifying probability, uncertainty and risk in natural hazards. The programme is being undertaken by 14 institutions within the EU from 4 countries and 3 institutions from outside Europe. The quantification of risk for hazards such as floods, windstorms, earthquakes, tsunamis, droughts, lahars and volcanic ash dispersal is an area where little empirical data will typically be available due to the extreme nature of the events and as such is an important application area for the use of SEJ to assess uncertainty.
Another project which represents an application area in which SEJ plays an important role is on reliability concepts for large (pan-European) power systems. A proposal for the project has been submitted as part of EU-FP7. The proposal involves a number of participants in this COST proposal and could produce a case study on using Structured Expert Judgement, but does not overlap with

this Action.
There are also projects, involving participants in the Action, which involve the application of expert judgement methods in the assessment of volcanic hazards. These are the ESF network MEMOVOLC, the EU funded NEMOH network and the V1 project funded by the Department of Civil Protection in Italy.
The application of SEJ plays a small but crucial part in each of these projects. This is a representation of the potential use of SEJ across many technical areas including a large number of COST Actions. A unifying SEJ network will allow the experiences of SEJ across different technical sectors to be shared and expertise to be transferred to new sectors.

C. OBJECTIVES AND BENEFITS

C.1 Aim

The aim of the Action is to establish a multidisciplinary network of scientists and policy makers around the use of structured expert judgement to quantify scientific uncertainty in support of evidence-based decision making, that through new scientific development, training, and the spread of good practice, will improve understanding, communication and effectiveness in the use of scientific knowledge amongst policy makers.

C.2 Objectives

The Action's Secondary Objectives (AOs) are
AO1 Coordinate and stimulate new research around themes of SEJ Process and Performance, Dependency elicitation, and Uncertainty modelling, providing a state-of-the-art overview on these research areas taking place outside the Action and their influence on policy making, making this available via the Action website.
AO2 Establish a program of short-term scientific missions (STSM), and exchanges between the Action’s participating countries in order to foster effective information exchange among scientists and facilitate harmonisation of approaches.
AO3 Develop and publish case studies around the implementation of SEJ to assess uncertainty in science, technology and commercial domains, in direct collaboration with specialists in these domains.
AO4 Create a stakeholder group consisting of Chief Scientific Advisors and others in influential science policy makers, to inform new research, and reduce barriers to successful exploitation of

SEJ.
AO5 Establish a training programme for Early-Stage Researchers to help them communicate their research work to policy makers.
A06 Disseminate the outcomes of the Action to the wider scientific community through regular scientific meetings, regular thematic workshops, an international conference, and the Action website.
Taken together these Objectives will provide a step change in the theory and practice of SEJ in participating countries, with policy and decision makers aware of the benefits using SEJ approaches to support evidence-based decision making, a research base developing new methods and approaches to overcome barriers to acceptance, and a network of specialists in areas of science, technology or commerce who are able to apply SEJ approaches within their own areas of expertise.

C.3 How networking within the Action will yield the objectives?

For this Action to succeed we need to ensure the creation of a vibrant network bringing together diverse members of the three communities of scientists, SEJ researchers and policy/decision makers. A step change in the theory and practice of SEJ specifically requires exchange in:
• Knowledge and experience between SEJ researchers and stakeholders from the policy community
• Knowledge between SEJ researchers and scientists from different domains around the methodologies involved in characterising scientific and social uncertainties in decision making.
• Development of stronger methodological consensus amongst SEJ researchers, and new approaches to the main research problems.
The Action networking activity will provide the interactions required in each of these 3 key areas.

C.4 Potential impact of the Action

A step change is possible in way scientists interact with decision and policy makers through SEJ. But at the current time most decision and policy makers are not aware of the potential benefits of SEJ methodologies as a way of supporting evidenced based decision making. This Action will create new collaborations and enable policy makers to drive the direction of future research in the area by highlighting potential barriers to exploitation.
The scientific impacts of the action objectives on the SEJ field are that it will establish and grow the dynamic network of researchers; it will provide impetus to research by generating new questions from interaction with other research fields and decision/policy makers, and it will train a new

generation of young scientists who in turn will deliver high quality future research which has real impact and influence on European policy and European industry.

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Finally, the Action will impact on other research fields by providing new methods for model quantification and validation, and on the commercial world by providing a set of transparent and more defensible models for uncertainty quantification.

C.5 Target groups/end users

Within the Action we distinguish two target groups. The first are stakeholders – individuals and groups who are themselves policy makers/decision makers, or who directly interface with them. These include for example: Leaders of Science Institutes that provide advice to Government, and Chief Scientists. The second group consists of science end users. These are specialists in areas of science, technology or social science who provide, or have the ambition to provide, advice to policymakers around uncertainties within their domain.

Representatives of both groups have been involved in constructing the proposal. The largest group is of science end users where there are communities in the geological sciences and food sciences where there is an established base of SEJ practitioners. These individuals not only practice SEJ, but also contribute to new research by highlighting areas where development is needed. Science and technology managers have been involved in the proposal construction, along with managers with strong technical and commercial experience.

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

The network looks at the ways in which we use structured expert judgement methods in science and policy/decision support to assess uncertainty, and through that, to look at the way risk is assessed. The difference between structured and unstructured expert judgement, lies in the processes used to ensure that the data is captured in the best possible way, free from as many biases as possible, and subjected to quality control. SEJ methods have been discussed for at least 30 years in the scientific literature, with the landmark book of Cooke “Experts in Uncertainty” in 1991 setting out the methods available at that time.

While the scientific literature on SEJ has been evolving, its application in different technical, scientific and commercial domains has been slower. A relatively small number of academics have

consistently applied SEJ methods and even fewer have collected data about expert performance. Furthermore, big issues remain, both at the methodological level – particularly in terms of modelling dependencies – and at a foundational level – where many are critical about the capacity of probabilistic models to adequately capture important aspects of mid to long term changes. On the other hand, good experience has been developed about the application of these methods to a variety of different application areas, including technological risk assessment. The extension of existing methods into new areas of scientific and technological endeavour, and the development of a body of experience and expertise in those areas, will provide the benefits of improved assessment of uncertainties and ultimately more transparent approaches to assessing and managing risk of complex systems in the modern world.

The scientific focus of our proposal is divided into three broad themes: Methodology; Foundations; Technical, Scientific and Commercial application areas.

We discuss each in turn, but stress that our approach is to be flexible: other scientific questions will undoubtedly arise, particularly from the Action's interaction with technical, scientific and commercial application areas. We shall take account of this by scoping in detail only the first two years of the plan, and ensure that we can plan the COST Action activities more flexibly in the second half of the programme.

Methodology - Within the broad approaches taken to capture expert assessments of uncertainties there remain a number of key and vibrant research themes. These are:

1. Problem Structuring and Model Formation – Determining the main features of a problem together with stakeholders (who may be domain scientists, technologists, or managers/public servants depending on the area of application), provides the context for structured expert judgement. This involves identifying inputs and outputs, major influencing factors, a common understanding of the purpose of the model and so on. Next is deciding how the problem will be modelled – the choice of statistical black box model, physics model, or other hybrid models containing varying degrees of causal, empirical, or theory based sub-models. For complex problems the corresponding models typically show high levels of sensitivity to initial conditions and to parameter choices. The main focus of work will be constructing models that can be validated at a broad brush level by using structured expert assessments to assess expected behaviours. This will allow a more effective, systematic and defensible approach to validation than is common in the development of large computational models.

2. Expert judgement processes – the scientific literature contains a variety of different expert judgement processes. Aggregation of (typically) different views of experts has been broadly categorized into behavioural and mathematical techniques. The extent to which behavioural techniques based on group workshops will lead to inadvertent anchoring bias between experts is not well understood, and hence the trade-off between "improved mutual understanding" on the one hand and "discussion leading to group-think" on the other is not considered. The focus here is to provide practical overviews of such issues and stimulate the development of guidance to help project leaders select the best process. This is particularly relevant to the commercial application of expert judgement methods where there may be a cost-quality trade-off, and the transparency of the methodology is still important.

3. Expert performance measures – how do we distinguish those experts who are good at assessing uncertainty from those who are poor? The ability to assess uncertainties is not necessarily correlated with domain expertise and studies have shown dramatic differences (post-hoc) in performance between experts. Since the intent of a structured approach is to improve the quality of expert assessment, then some measure of expert performance is needed. Here we explore different performance measure methods (e.g. equal weights as used by US Regulatory Commission, the Classical model of performance based weights by Cooke), and take an in-depth look at the existing data around previous expert judgement studies (e.g. using the TU Delft database) as well extensions to include other studies and performance measures. Related to performance measurement is the issue of expert learning and feedback. It is known that the ability to make assessments of uncertainty can be learned and that expert calibration can improve through training and feedback. The opportunities for feedback will vary with context. The aim is to explore the impact of different types of training on expert performance, and consider how such training might be used to improve uncertainty assessment.

4. Reporting expert judgement studies – there is less awareness of the documentation, reporting and peer review of expert judgement studies relative to empirical studies. Some guidance is available, but there is little consensus on what should be reported, relating to expert selection processes, elicitation procedures, calibration data, unadjusted judgements (i.e. actual responses), etc. The degree of anonymity of the experts is particularly contentious.

5. Expert assessment of statistical dependency – one significant area of open research problems is that of assessing statistical dependency. It is well understood that dependencies are extremely important in driving the predictive behaviour of risk models, and that mistaken assessments of dependency, alongside the non-inclusion of significant factors, is one of the key factors in deviation between model-based predictions of risk and real-life experience. Dependency assessment will be a major theme throughout the lifetime of the COST Action. Current methods either look at assessment of conditional distributions or at correlation coefficients, which are, respectively, time consuming and abstract.

6. Structured preference modelling – there has been a recent move to use expert judgement to assess the distribution of preferences across a group of stakeholders. In the context of societal decision making this is one route into looking at the ranges of reactions that might arise amongst members of the public, and therefore provides a completely different methodological approach to the more standard ways of assessing how people will react by asking how they think they might react.

7. Use of expert judgement derived uncertainties to quantify model/model-parameter uncertainty – a key methodological insight is that experts should only be asked to give uncertainty assessments about real world quantities, i.e., quantities that could in principle be measured by other means. Since model parameters are often (but not always) abstract – for example power laws, transfer functions etc. – there is a need to translate the expert assessed uncertainties into uncertainties on the model parameters.

8. Foundations - While foundational issues are not intended to be central in this COST Action, it is important to consider those that are particularly relevant to the decision and policy paradigms we shall support. Two themes will be particularly important to address. The first is linked to the methodological issue of problem structuring and relates to the typology of uncertainty. Too often attention is restricted to elements of uncertainty that are commonly understood and modelled, while ignoring others (e.g. at a conceptual level, or at the other end of the spectrum, in management). Societal experience of risk management consistently shows that the unmanaged and ignored areas of deep uncertainty are the ones that create problems. The second, related, area is the distinction made between known-unknowns and unknown-unknowns, or the efficacy of the probabilistic approach. This can be traced back to the differences of

approach adopted by Savage and Ramsey, on the one hand, and Keynes and Knight, on the other. Horizon scanning approaches to futures modelling implicitly take one side while most economic modelling approaches implicitly take the other. It is timely to revisit these issues in the specific context of expert assessment and explore how hard the dividing line really is.

9. Technical, scientific and commercial application domains - A significant objective of this COST Action is to spread expertise and understanding of structured expert judgement methods into different technical, scientific and commercial domains, and then to feedback and learn from the experience. We will strike a balance between different types of application area, by considering some where there is already experience of SEJ, some with little experience; some in science and technology and some in commerce. There is considerable expertise already in earth science, particularly in volcanology. Similarly there is already experience within the area of food technology. On the commercial side there is interest in applications to insurance, to technology forecasting, and to project management.

Two meetings per year will be devoted to methodological developments. One per year will be on a specific topic: in year 1 expert assessment of dependency; in year 2 foundational issues in uncertainty modelling. The second meeting of the year will be general and devoted to a range of issues. A flexible approach will be taken to organise workshops in different application domains, with at least two being held per year. Over the course of the COST Action,

- At least two workshops will be held in conjunction with other COST networks, where the Management Committees of those networks see the possibility of collaboration. We shall work with the COST Office to develop the required linkages.

- At least two workshops will be held in conjunction with government agencies and with the support of one or more person of Chief Scientist or similar status. This is intended to improve demand for methodologically strong approaches to expert assessment.

- At least two will be held around commercial topics where improvements in expert forecasting could lead to economic benefits for the EU.

D.2 Scientific work plan methods and means

The main activities used to realize the scientific work plan and achieve the Action objectives are:

- Scientific meetings (2/year) open to COST participants
- Workshops, each focusing on problem of uncertainty assessment from a particular domain, (2/year) open to COST participants, stakeholders, regulators, decision/policy makers, wider audience
- An international conference (to be organised towards the end of the 4th year) open to COST participants, decision/policy makers, wider audience
- A training course aimed at Early-Stage Researchers (ESR) to ensure that they are aware how to influence evidence-based policy and thus ensure their work can impact regulators and decision makers. Open and accessible to other COST Actions.
- Doctoral/ESR Colloquia. In addition to the training course in each of the other three years a one-day colloquium, adjacent to one of the Action's workshops or scientific meetings will be held to mentor Early-Stage Researchers associated with the Action in research methodologies that are important in SEJ.
- An Action public website – accessible by COST participants, regulators, DMs, wider audience/public

These activities and the objectives of the Action will be organised by 5 working groups.

- WG1 – Processes and Performance Research Group
- WG2 – Dependence modelling
- WG3 – Uncertainty modelling and foundational issues
- WG4 – Technical, Science, and Commercial applications and knowledge exchange
- WG5 – Early-Stage Researcher Training

The WG1-3 focus on specific methodological research issues, with Topics 1-4 covered by WG1, Topic 5 by WG 2, Topics 6-8 by WG3 and Topic 9 by WG4. Besides being responsible for development of new applications and case studies, WG4 will feed the results of the applications and of stakeholder views on methodology back to WG1-3. WG5 focusses on Training, using inputs from the other WGs.

E. ORGANISATION

E.1 Coordination and organisation

The Management Committee with representatives from the main collaborating institutions and countries will be responsible for coordinating the programme. Within the Management Committee specific members are assigned to act in the roles of

- Gender balance coordinator,
- Dissemination and Knowledge Exchange coordinator,
- STSM coordinator,
- Publications coordinator.

This highlights the significance of these roles in ensuring the proper management of the Action, of successfully reaching out to the wider community, and ensuring quality research exchange.

In addition to the WGs, a Stakeholder Group will also be formed. The Stakeholder Group will consist of senior policy makers and science advisors, together with key representatives of commercial stakeholders, who will advise about issues challenges to SEJ acceptance at senior policy/ministerial level. The Dissemination and Knowledge Exchange coordinator will work specifically with the Stakeholder group to ensure not only that SEJ and SP research is disseminated to the user community, but also that SEJ and SP researchers are made aware of the barriers to successful adoption and can therefore develop new processes and methods that deal with these barriers.

The successful establishment, early in the Action, of the Stakeholder Group is the most important milestone in the development of the project. Contact has already been made with a number of suitable candidate members, and membership of the Group will be flexible, allowing other countries and organisations to contribute to its work as the Action progresses.

The other important – but significantly less complex - milestone for the Action is the creation of WG Leaders and supporting executives.

The WG's have the major role in coordinating research from the participating countries, reviewing existing research and practice in SEJ, organising STSMs and meetings around the priority themes, ensuring dissemination, and working with the cross-cutting WG that organises the Early-Stage Researchers Training. The STSM coordinator will have the job of quality managing requests that come in from different WGs and hence ensuring that a uniform high quality standard is applied.

The MC will ensure that budgets are apportioned appropriately to each of the WGs for the different activities that they will organise. Each WG will be asked to produce an action and prioritization plan conforming to a common framework in which the topical meetings, review deadlines and STSMs are used effectively to drive the creation of outputs from the WG. The MC will encourage the use of web-based interaction both for collaboration and enhancing participation at events (albeit remotely), not least because this will reduce the barrier particularly for commercial participants.

The role of the Publications Coordinator is to ensure that WGs provide research outputs, case studies etc to be published and disseminated via the website. Publications include multi-media, as the workshops will all produce quality video outputs of key sessions and events that will be published via the website, and participants, especially Early Stage Researchers, will be encouraged to reach out to a wider public. The Publications Coordinator will collaborate with WG Chairs and with the MC to ensure that the Action website is fully up to date.

E.2 Working Groups

The main organisations used within the Action are Working Groups, with 4 research-focussed WGs: WG1 – Processes and Performance Research; WG2 – Dependence modelling; WG3 – Uncertainty modelling and foundational issues; WG4 – Technical and Policy applications and knowledge exchange; and one training-based WG: WG5 – Early-Stage Researcher Training.

WGs 1-3 have the same set of responsibilities, with each being charged with coordinating research around their specific themes, organising Scientific Meetings, and generating outputs including an area review document, ensuring output of a methodology guide and inputting into the WG4 and WG5 activities.

WG4 is responsible for interacting with other COST Actions and stakeholders from the technical and policy domains. It will organise the Workshop activities, produce case studies for the website,

and input into WG5.

WG5 is responsible for organising the Early-Stage Researcher Training, drawing on inputs from the other WGs, in particular the case studies produced by WG4. It will also produce a set of on-line learning materials for the website that can be used as an introduction to the area for researchers not able to attend the Training.

Each WG will have a Chair responsible for reporting back to the MC, and a supporting WG executive. The MC will coordinate the meetings of the WGs to create the overall programme for the Action, and through its coordinators will ensure that gender balance, knowledge exchange requirements are met, alongside consistent quality of STSMs and publications.

E.3 Liaison and interaction with other research programmes

Since one of the main objectives of this Action is to spread the use of SEJ and SP methods through into new scientific domains, and use the experience of applications in new areas to highlight new research needs, the interaction with other research programmes is quite fundamental. Other COST Actions are to be approached with a view to establishing a joint workshop looking at potential applications of SEJ in their area. The Training School opportunity for Early-Stage Researchers is also a way of benefiting members of other COST actions, and thus also building up potential research users with expertise in SEJ.

The UK NERC PURE Programme to develop new methods for quantifying probability, uncertainty and risk in natural hazards, the project on reliability concepts in large power systems submitted to EU-FP7, the ESF network MEMOVOLC, the EU funded NEMOH network and the V1 project funded by the Department of Civil Protection in Italy are all application areas relevant to the Action as detailed in section B.4. These projects are to be similarly approached with a view to identifying opportunities for the application of SEJ.

E.4 Gender balance and involvement of early-stage researchers

This COST Action will respect an appropriate gender balance in all its activities and the Management Committee will place this as a standard item on all its MC agendas. The Action will also be committed to considerably involve early-stage researchers. This item will also be placed as a

standard item on all MC agendas. The Action will particularly seek to provide leadership opportunities and mentoring, with the support of many of its high profile successful female scientists.

Early-stage researchers are key to the success of the Action by spreading knowledge of SEJ methods through different scientific communities. The Early-Stage Researcher Training school activity aims to give them a good understanding of risk and uncertainty matched to a set of practical skills in SEJ methods. This will give the knowledge, understanding and confidence to be able to apply SEJ methods in their own areas. The training activity will be widely advertised, in particular through other COST networks in order to attract scientists into the area and therefore increase future capacity.

F. TIMETABLE

The Action will last for 4 years.

Year 1:
MC and Stakeholder Group establishment. Initial Scientific meeting held, including Stakeholder input to research; exchange of case studies. Website established based on outputs of initial meeting and case studies. Workshop on Geohazards. Scientific meeting on dependency modelling and assessment (WG3).
Year 2
Two scientific meetings will be organised led by WG1 and WG2. Two workshops will be organised around the themes of Food Safety and Insurance. The Early Stage Researcher Training will be held.
Year 3
Two scientific meetings will be organised, themes to be decided depending on WG progress. Two workshops will be organised around emerging application areas.
Year 4

Two scientific meetings will be organised, themes to be decided depending on WG progress.
Two workshops will be organised around emerging application areas.
An International Conference will be held to disseminate the results of the Action, involving SEJ researchers, members of the Stakeholder Group, and scientists/business people from application area.

G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: AT, CH, DE, ES, FI, FR, IT, NL, NO, UK. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 40 Million € for the total duration of the Action. This estimate is valid under the assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.

H. DISSEMINATION PLAN

H.1 Who?

This COST Action can only be successful if it enables the successful dissemination of SEJ methods to scientists in areas of possible application, and to policy and decision makers so that they can see the benefits of an SEJ approach in supporting risk assessment.

In all cases benefits will be enjoyed by the SEJ research community through providing new research questions and opportunities to develop application specific methods. The dissemination programme is therefore an integral part of the research approach in this Action.

A primary target audience for dissemination is researchers in scientific and technological fields where there is a need to provide science based assessments of risk. By bringing together researchers in SEJ good practice can be shared and a methodological consensus can be developed. By targeting research institutes and academia the project will raise awareness of the track record in the successful application of SEJ in a great many problems across a variety of fields.

A further, more specific, target audience within the field of research and academia is young researchers. The Action will ensure that early-stage researchers are comfortable when dealing with

uncertainty and familiar with the availability and use of expert judgement as this is crucial to the improvement in the understanding, communication and effective use of scientific knowledge in the policy process.

The Action will also include European level policy makers and Government policy makers as an important target audience. It will interface with government scientific advisors in order to make sure they are aware of the possibilities associated with SEJ within all areas of science. This will ensure greater acceptance of SEJ procedures within policy development and will help to create demand for SEJ solutions to aid in decision making under uncertainty.

As SEJ methods have applicability in a wide range of fields, a further important target audience is industry. SEJ methods have already been applied in the commercial areas of technology forecasting and insurance and the Action will build on these links by engaging with industry to further develop and implement applications of SEJ. In order to impact further on industry, the Action also targets regulators, in particular those associated with risk assessment and risk management.

The Action will establish links to disseminate results to other COST Actions. Uncertainty analysis plays an important role in risk and decision modelling, covering a wide range of domains. The proposers of this Action have taken part, or know of, applications of scientific expert judgement across a wide variety of application areas, including those of the COST domains: Biomedicine and Molecular Biosciences (BMBS); Earth System Science Environmental Management (ESSEM); Food and Agriculture (FA); Individuals, Societies, Cultures and Health (ISCH); Materials, Physics and Nanosciences (MPNS) and Transport and Urban Development (TUD).

H.2 What?

To meet the objectives of the Action and achieve the impact set out several dissemination techniques, each aimed at multiple audiences, will be used. They are:

- Public website: the website will be a hub for the Action. It will contain details of the workshops, conferences and training courses organised by the MC, access to the password protected website, details of the electronic communication network, publications such as interim reports, case studies, guidelines and manuals, etc. links to articles in journals relevant to the action and links to non-technical publications. It will

be an important point of dissemination for all of the target audiences, with short courses and webinars designed for the public, for policy makers, for scientists and business.

- Scientific Meetings: These will be open to COST participants and are therefore primarily for researchers in the fields.
- Workshops: These will be targeted at researchers, industry, DMs, regulators and Standards Bodies.
- International Conference: This will be in year 4 of the Action and will be used to disseminate the overall results of the Action to all of the target audiences.
- Password protected website: used for the posting of working documents for researchers in the field and research institutions and Academia.
- Training Course: This will engage young researchers in academia and research and will include those from industry who are interested in learning about SEJ.
- Electronic Communication Network: This will be primarily for researchers in the field and research institutes and Academia. There will also be the opportunity for those in industry to access expertise from those in the field of EJ via the network.
- Publications: interim reports, case study reports and proceedings from workshops and the conference will be targeted at researchers and those in Academia.
- Guidelines and manuals will be disseminated to those in industry as well as policy makers at Governmental and European level as they are more accessible than heavily technical documents.
- National Media: Involvement in the National press, television and online media will target the wider scientific community and the general public.

H.3 How?

The workshops, which will be held twice a year, will be a primary method of active dissemination in the Action. At least two of the workshops will be joint with other COST networks, so that those involved in the SEJ Action can network and present and explain their work directly to those in other

Actions. This will also create collaborations between researchers in the Actions.

At least two of the workshops will be held in conjunction with government agencies so that contacts are made between those in the SEJ network and those administering policy. This will enable policy makers to develop an understanding of where SEJ has a role to play. Further, at least two of the workshops will have a commercial or industry focus. This is crucial as application of SEJ lags behind theoretical development and so by networking with those in industry at the workshops the fields of application of SEJ will increase.

By engaging actively with all of the target groups through workshops, scientific meetings, training courses and a conference, on top of the more passive types of dissemination such as the website, publications in journals and manuals, the Action will create knowledge in, and demand for, the use of SEJ, which will simultaneously filter down from chief scientific officers and up from those in academia and industry. Policy at a national or European level is made by elected representatives. Below these politicians is the policy community, for example chief scientific officers and civil servants, who carry out much of the analysis around policy and inform the policy makers. A level below this is consultants, who typically have a toolkit of expertise which aids the policy community. Cutting across all of these groups are the technical areas which make up the focus of COST Actions.

By engaging researchers in the field and the wider scientific community, this will influence the technical areas which cut across and inform government policy feeding up to inform policy. The training courses for young researchers will also improve the knowledge and expertise of SEJ at a slightly higher level in the process as researchers progress and some become consultants. The interaction with policy makers, such as government scientific advisors, will raise awareness in the policy community of SEJ and this will filter down through the process towards the technical areas.