NATO Advanced Research Workshop

Foresight, precaution and risk: preparing for the unexpected

Learning the lessons from past crises and catastrophes
to enable early and effective response to future risks

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Abstracts

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Overview

Risk preparedness in the arena of environmental security and health requires prior knowledge and timely response. We need to have advance warning of new or emerging risks, to be able to communicate information about the risks to those who need to know, and to be able to take appropriate action in time to avoid or reduce the risks and their consequences.

All aspects of risk management - monitoring, assessment, communication and response – thus need to be in tune if risk preparedness is to be effective. This poses severe challenges when the risks are already known; it demands even greater insight and flexibility of response in the face of uncertainty, or when the risks are essentially unknown.

This NATO Advanced Research Workshop will explore the ways of meeting these challenges by

- drawing upon the lessons to be learned from past catastrophes and crises, it will examine how best to foresee and respond to unexpected risk events – through application of the precautionary principle, via prediction and foresight, and via preparedness for effective risk communication and management;
- using a series of case studies – on flooding, food security, bioterrorism, climate change and environmental pollution – it will demonstrate and assess methods for effective risk prediction, risk communication and risk response; and
- through involvement of scientists, service providers, media and policy-makers, it will provide a frank and informative exchange of experience between the many different stakeholders involved in risk preparedness and risk response.

Papers presented at the NATO Advanced Research Workshop and contained in this booklet will be published as a book in the NATO Science Series.

Abstracts

Basic concepts of risk characterisation and risk governance: guidance for the development and implementation of appropriate risk governance strategies

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Founded in 2003, the International Risk Governance Council (IRGC) is a Swiss-based private foundation funded by voluntary contributions from the public and private sectors. Its mission is to support governments, business and other organisations and to foster public confidence in risk governance and in related decision-making by

- reflecting different views and practices and providing independent, authoritative information;
- improving the understanding and assessment of important risks issues and ambiguities involved;
- designing innovative, efficient and balanced governance strategies.

During 2004 and 2005 IRGC has undertaken project work, led by Professor Ortwin Renn of the University of Stuttgart, with the objective of developing a framework for characterising risks and using the characteristics of a particular risk to assist in designing an appropriate risk governance strategy. This framework is initially intended for internal use – to give structure to IRGC's work on specific risk problem fields such as critical infrastructures, nanotechnology and integrated disaster risk management – but it is also hoped that it will be of benefit to all risk practitioners and decision makers, particularly in helping them to broaden their approach to framing, assessing and managing the risks for which they are responsible.

IRGC's work on this project has included an overview of many existing frameworks, both for governance (e.g. the OECD; Asian Development Bank) and for risk (eg the Australian and New Zealand standard; US 'Red Book'). From this overview, and drawing on inputs which include a technical workshop in late 2004, the IRGC has developed a multi-dimensional approach which, it is hoped, will have relevance to most risk types and contextual circumstances. The framework includes the classical components of risk assessment, management and communication, and adds a number of other elements which provide further assistance in designing the appropriate risk governance strategy. These include a knowledge challenge, which requires an assessment of the problem's complexity, uncertainty and/or ambiguity, a judgement of the potential risk's acceptability (or otherwise) and the choice of a particular risk management strategy that fully reflects both the nature of the risk and the level of knowledge surrounding it. The risk management strategy itself should include appropriate communication activities, particularly if and when stakeholders – including the general public – become part of the decision making process.

Following a brief overview of why IRGC has undertaken this project, Mr. Bunting's presentation will outline the framework and show how risk characteristics can be used to develop an appropriate risk governance strategy.

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Theories in environmental risk assessments

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Environmental risk assessment (ERA) is a qualitative and quantitative evaluation of environmental status performed in an effort to define the risk posed to human health and the environment by the presence, potential presence, or use of specific pollutants.

ERA should be conducted when it is determined that a management action may have consequences to either humans or the environment. Effective conducting of ERA entails adopting a systematic approach, as shown in figure bellow.

ERA is comprised of two related disciplines: human health risk assessment (HHRA) and ecological risk assessment (EcoRA). The process for HHRA often involves the following steps:

hazard identification - the determination of whether a particular chemical is or is not causally linked to a particular health effect on human beings;

dose-response assessment - the determination of the relationship between the magnitude of the exposure and the probability of occurrence of the health effects in question;

exposure assessment - determination of the extent of exposure;

risk characterization - description of the nature and often the magnitude of risk including attendant uncertainty.

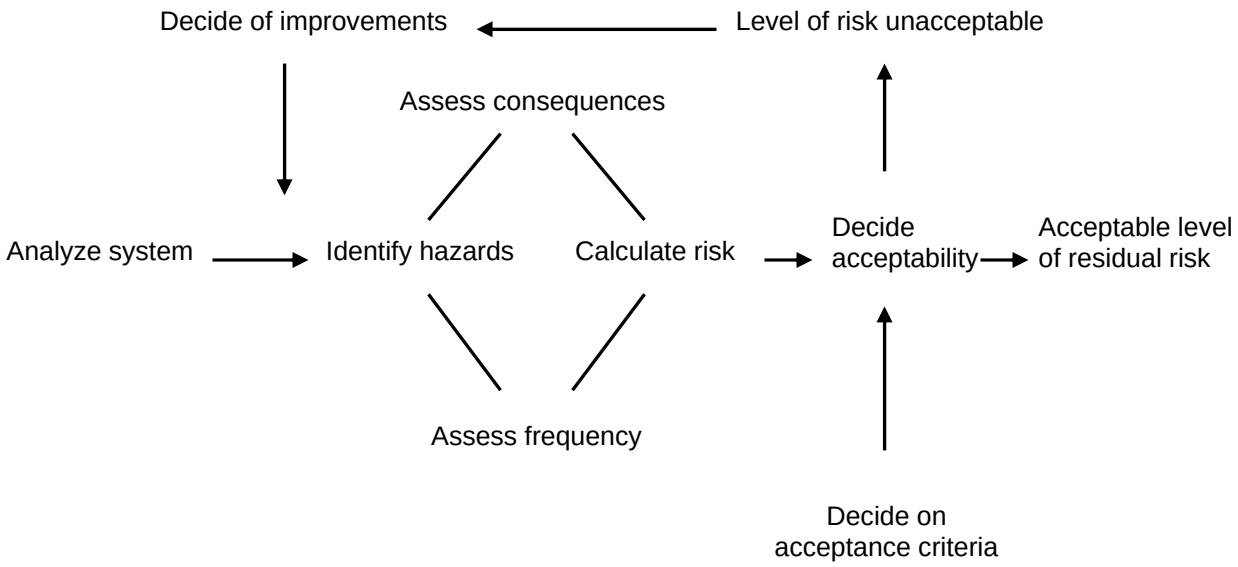

Figure 1. Systematic approach to risk assessment

(Source: *Environmental Risk Assessment for Sustainable Cities*, Technical Publication Series [3], International Environmental Technology Centre, Osaka, 1996)

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EcoRA is conceptually similar to the approach used for HHRA. During this assessment, the likelihood of the occurrence / non-occurrence of adverse ecological effects as a result of exposure to stressors is determined. The term "stressor" here may be defined as any chemical, physical, or biological entity that can induce adverse effects on individuals, populations, communities, or ecosystems.

The paper includes comments the definition of the environmental risk assessment, associated terminology, environmental risk assessment and the project cycle, ERA builds upon environmental impact assessment, basic approach to environmental risk assessment, characterization of risk, risk comparison, quantitative risk assessments, risk communication, risk management, guidelines for disaster management planning.

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Risk assessment in the region

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This paper describes an index method for complex risk assessment at the regional scale. The method is based on comparing critical indicators with acquired data. The data are then transformed into non-dimensional integrated indexes. Different risk spheres can be compared in this way.

A hierarchical structure of indexes is built in each area of interest. The compound integrated index is a weighted sum of the marginal indexes, each describing different security aspects.

The proposed method enables the assessment of regional security fully and comprehensively. It is based on using a large number of critical indicators, which reflect the risk from various spheres of human activities. The method also enables the risk priorities to be determined on an individual level, or specific areas within the hierarchical structure to be assessed. The degree of specificity of risk assessment at the basic level, and the extent of assessment, depend on the intentions of management authorities.

The proposed methodology was verified for the areas of health, environmental and technological risks through the AZER project outcomes. Fourteen health risk subareas were assessed in the study region. Partial and then compound integrated indexes were determined for each of these subareas. Based on the resulting index values, the following areas were proposed to have a high priority: non-infectious diseases, air quality, waste management, injury rate of children and young people. It was shown that the sphere of technological risks also deserves attention by the administrative authorities.

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Approaches to integrated risk assessment and management

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Risks are complex phenomena. They involve both a reality and a perception, both a force and a reaction. The reality of any risk may, itself, be multifaceted. Individual hazard events may cluster differentially in time and space, may propagate through a wide range of different mechanisms and pathways, may generate a wide range of supplementary hazards, and may have many different impacts that are distributed unevenly across the population. Perceptions of these risks vary also, according to the stage at which they are seen, and the individual and social characteristics of those concerned. The way in which we respond to risk provides a further layer of complexity. It depends not only on the reality and the perception of the risk, but also upon our individual ability to act – as determined, for example, by our physical, economic and power status. It depends, in addition, on how we expect others to act, and our perceptions of their roles and responsibilities in relation to the risk, and our own perceived role within that cast of actors.

Successful risk management thus requires we take account of all these complexities. This requires integrated approaches to risk management: approaches that encompass not only prediction, preparedness for and management of the hazard and its consequences, but also prediction, preparedness for and management of people's perceptions, expectations and behaviours in the face of that risk. Achieving this poses major challenges. It implies the ability to track and respond to risks in a more co-ordinated way: across different hazards, different effects and different geographic areas. It requires the ability to follow risks from their origin or precursors through to their impact, and beyond until recuperation is complete. It requires the ability for individual and organisational learning, so that the lessons from one event can be translated into better preparedness and better response for the next. It requires that the procedures of risk management – prediction, impact assessment, monitoring, communication and response – are seamlessly linked. It requires that the individuals, institutions and agencies involved in risk management work together, and share information, effectively. It requires that risks are dealt with on behalf of all the stakeholders concerned, and this means that those stakeholders are known, their perceptions and expectations understood, their roles and capabilities appreciated, and their participation assured.

This paper discusses the principles behind integrated risk management from this wider perspective. After setting out the concepts, it presents and compares frameworks and models of risk assessment and management and suggests ways in which they can be linked and improved to provide a more robust basis for action. With reference to specific examples, it then reviews some of the tools available for integrated risk management and concludes with a discussion of the gaps and weaknesses that need to be resolved if effective systems for integrated risk management are to be established.

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Urban seismic risk studies with utilization of GIS

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Geographical Information Systems, *GIS*, have been found to be very useful in hazard and risk assessment studies. GIS can be used to integrate vast amounts of data geographically, take the spatial distribution of phenomena into consideration and communicate the results graphically performing analysis of complex mathematical models. The case study of the current paper is seismic risk assessment of building facilities in the central part of Kishinev (area 6.3 km^2), capital of the Republic of Moldova. This city is exposed to seismic hazards from the Vrancea zone, with mean peak ground acceleration from attenuation effects for medium soil conditions PGA $\approx 2{,}0 m/s^2$ for recurrence interval $\hat{T} = 475 yrs$. Collection, classification and digitization of data were undertaken in ArcView GIS for the main characteristics of the subsoil, such as mean shear wave velocities, and damping ratios. Data on existing facilities and a digital terrain model (*DTM*) were also constructed. The final product is the *GIS* database and software module for assessment of seismic damage to buildings. Rapid assessment of scenarios of seismic events and mapping of parameters of the ground motion is possible through the software application.

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Seismic risk modeling at regional and local scales

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The first part of the contribution presents attempts to evaluate the relative seismic risk distribution in Republic of Moldova. This territory regularly suffers heavy damage and losses as a consequence of medium depth earthquakes located in Vrancea zone, Romania. The last strong earthquake (August, 30, 1986, M=7,0) caused 2 deaths, 561 injured persons, 1169 completely destroyed buildings, and around 800 millions $USA direct loss.

Seismic risk in this study has been determined as the combination of earthquake hazard and seismic vulnerability. Earthquake hazard has been evaluated on the basis of map which was produced taking into account the maximum seismic intensity observed, soil amplification capacity, topography and underground water level. Seismic vulnerability was determined as a combination of physical environment vulnerability, quality of structures (number of suffered earthquakes), population features and relative value of loss. The vulnerability of physical environment was estimated on the basis of the map, which was produced taking into account the areas affected by landsliding, liquefaction, with different densification capacity and degree of slope abruptness. The spatial distribution and density of the population were considered the most important factors in the investigated territory. As a measure of relative value of loss, the index of economical activity each of districts was used.

On the basis of these data, four classes of relative risk were suggested (low, intermediate, high and very high) and the large-scale (1:500 000) map of relative seismic risk constructed. According to this, the earthquake risk is not consistent with earthquake hazard and reaches highest levels of concern in the central region of Moldova Republic where the population is denser, economy is better developed and the secondary effects of earthquakes are more likely.

In the second part of the contribution results from a PC-based earthquake loss estimation software application are presented. The system has been developed in order to control and reduce the local (urban) seismic risk in Republic of Moldova. The application evaluates damages to built facilities and casualties from scenario and historical earthquakes in conditions of the limited initial information on the base of seismic hazard assessment of Vrancea zone, taking into account directivity effects, local soil conditions and vulnerability of the existing building stock in Moldova.

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Rapid preliminary evaluation of direct flood damages

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The consequences of floods on humans and society have been known for a long time, the most significant of them being the loss of human lives, destruction of homes and economic sites, crops, goods, famine, diseases, individual trauma, social disintegration, etc.

Romania is one of the Danube countries in which a large part of its territory is vulnerable to floods. Consequences of flooding have exceeded the impacts of any other disaster in the area.

Regardless of the nature of the floods and the causes that generate them, they have something in common: they produce direct and indirect damages. The direct damages include the loss of human lives, adverse effects on health and destruction or loss of goods, structures, crops etc. Indirect damages refer to losses caused by hindering human activities. Generally, in the case of floods, only direct damages are considered, commercial units being reluctant to give information about indirect damages.

Damages produced by floods are rarely studied on a global scale, and calculation of such impacts is rarely undertaken for its own sake, instead being determined only in order to point out the benefits obtained as a result of projects implemented to reduce the risk of flooding.

It is very important that evaluations of flood damages can be done prior to designing schemes of water development and management, or development plans, and before emergency situations develop, when decisions have to be taken under pressure of time and possible hazardous phenomena. Generally, in such situations the available database is especially poor. This fact makes a rapid evaluation of potential damages difficult.

Due to these reasons, the author of the present paper tried to determine a formula to calculate the prior value of damage, based on as small a number of parameters as possible, whilst still providing reliable and representative results. In this approach, the direct damages due to floods are computed on the basis of the following principles:

The bank full discharge has an important role in flood occurrence: the greater the value of this discharge is, the less floods occur;

The value of the flooded goods (residential buildings and other goods) can be described by a mathematical function of the number of inhabitants of that locality;

The value of the damage produced by floods depends on the depth of the water in the flood area and the duration of the floods.

Based on this, the following relation for residences has been obtained:

$P=kQ_e(Q_{ef}-1)h^xN^y$

in which:

P – damage inflicted to residences in ROL

Q_{ef} –discharge in the modelled section in m^3/s

Q_u – bank full discharge of the low flow channel

h – water depth in meters;

N – the population of the locality affected by floods in thousands of inhabitants

k – flood adaptation coefficient of that area

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x, y – exponents obtained on the basis of prior tests

On the basis of data on floods in Romania, the *k* coefficient can be determined as well as the values of ***x*** and ***y*** exponents.

For the flood damages to agricultural lands, the formula is:

$P=ah+bD$

in which:

P – flood damages in ROL/ha;

h – water depth in meters;

D – the duration of the flood in days;

a,b – parameters that have to be determined on the basis of empirical data.

Using the same data for flood damages to agricultural lands (loss of crops, soil erosion, alluvia depositing) numerical expressions for damage evaluation were determined according to the agricultural area.

The proposed formulae can be used with good results for rapid prior evaluation of flood produced damages to residences and agricultural lands.

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Ensuring financial stability of the protected areas

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Financial stability is the key aspect of the agenda of many managers involved in biodiversity conservation. Currently, however, most protected areas face major difficulties and financial constraints.

An essential aspect of financial stability is the ability to ensure the basic resources for functioning of the organization and for keeping sufficient reserves for survival in the case of the fluctuations of liquid assets.

Conservation of the protected area's resources is necessary, but nobody is prepared to support these costs directly, on the assumption that such costs should be born collectively by society. Thus, the idea of resource conservation has developed, in which those who benefit from the direct service offered by conservation will be prepared to pay for these services. This means that people are starting to understand that it is possible to reduce the burden of public expenditure through encouragement of private sector (individuals and communities) initiatives to capitalize the value of the biological diversity.

The person who must take care of the conservation is not the same as the one who must pay for this activity. In this context we could define three possible models of financing. The selection of the model will be dependant on certain factors, which have to be taken into consideration in order to assure the proper functioning and best practice that will provide financial stability of the majority of the protected areas, and minimize the risks of biological diversity loss in these areas.

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Nuclear and radiation safety management in Georgia

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Georgia is located in the South Caucasus region. Country size is 69,875 square kilometers. Georgia shares its state borders with Russian Federation, Azerbaijan, Armenia and Turkey. Western part of Georgia has broad seashore. There are two uncontrolled zones on the territory of country – part of former South Ossetia Autonomous district – so called Tskhinvali Region and Abkhazia which had the status of autonomous republic in the republic of Georgia in former times. Population is about 5 million inhabitants and the population growth is 0.87% due to data of the year 1994. Population density is 79 per square kilometer.

The South Caucasus region has one of the most complicated transit routes which allow for trafficking between Europe and Asia. As border control installations and infrastructure are, to date, insufficient, illicit trafficking and smuggling of nuclear and radiation materials continue to be a considerable problem. Intelligence service, regulatory authority, customs and border guards are working together in their fight against the threat of the smuggling and potential use of nuclear and radiation hazardous materials for criminal purposes. The Nuclear and Radiation Safety Service has been designated as the national contact point for the Illicit Trafficking Database Office of the International Atomic Energy Agency. There are also 24 hour warning points in operation.

There is only one NPP operational in the South Caucasus region. The distance from Metsamor NPP (Armenia) to National border of Georgia is about 150 Kilometers. Due to development and diversification of Energy Sector of Caucasus Region, establishment of new alternative sources of Energy production is subject of discussion. Only one nuclear installation placed on the territory of country (Research Reactor of the Institute of Physics) is not operational since 1997 and presently is under decommission.

The law of Georgia on Nuclear and Radiation Safety was enacted in 30 of October 1998. By law, the Nuclear and Radiation Safety Service of the Ministry of Environmental Protection and Natural Resources of Georgia is designated as the nuclear and radiation regulatory authority. The implementation process of the National Plan on Nuclear and Radiation Emergency Preparedness and Response was initiated in 2003. The adoption of the plan was set to aid authorities and decision makers in defining their obligations and functions until the end of 2005.

Georgia has been a member state of the International Atomic Energy Agency since 1996. The process of becoming of a member of IAEA Conventions has already started. Georgia collaborates with IAEA in the frameworks of Conventions on Non-proliferation of Nuclear Weapon, Early notification and Assistance, Safeguards and Additional Protocols.

Georgia is active member of TC projects both Regional and National, supported by the IAEA. Nuclear and Radiation Regulatory Authority (Nuclear and Radiation Safety Service) acts as a Country coordinator on international activities. Presently, cooperation with European Commission as well as DOE of USA is also considerable.

1989 – Cs 137 – Tbilisi, Co 60 – Kutaisi (no iformation about victims);

1992 – Ra 226 - Akhali Afoni (2 overexposed, one is dead);

1993 – Cs 137 - Zestafoni (no iformation about victims);

1996 – Co 60 - Kutaisi (2 overexposed, both are dead);

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1997 - Cs 137, Co 60, Ra 226 – Lilo (11 overexposed);

1998 – Cs 137 – village Matkhoji, Sr 90 – villages Khaishi and Laburtskhila (several overexposed among local population);

End of 2001 – Early 2002 – Sr 90 – village Lia (3 overexposed – 1 dead).

There are several governmental institutions responsible for Disaster Preparedness and Response in general. The main agencies include Nuclear and Radiation Safety Service of the Ministry of Environmental Protection and Natural Resources, Civil Protection and Fire Services of the Ministry of Interior, Center of Disaster Medicine etc. Presently, cooperation among those institutions is weak because the General National Plan on Disaster and Emergency Preparedness and Response has not been adopted yet. A Nuclear and Radiation Emergency Preparedness and Response plan is to be considered as a part of General National Plan, though this plan is still in its draft form.

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Risk of fresh ground water pollution by military activity

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The studied territory is used as the military aerodrome from 1947. Surrounded areas belongs to dens populated villages, which uses phreatic aquifer as the main source of fresh water both for domestic and economic purposes. Zone of aeration and shallow ground water has been polluted by Kerosene as a result of leakage of the craft fuel. Pollution includes aerodrome territory, villages dug wells and Raut River water. Rocks of the zone of aeration have Kerosene concentration in the interval 51.0 – 16800.0 mg/kg with statistical mean 1156.6 mg/kg. River water contains 1.3 – 3.5 mg/l petrol products, including Kerosene. Detected Kerosene in shallow ground water is divided in the three territorial zones. The first zone contains Kerosene till 1.0 mg/l and is classified as zone of polluted water. The second zone is the territory of intense polluted water with concentration of Kerosene 1.0 – 10.0 mg/l. The last, third zone is characterized as hard polluted and the concentration of the Kerosene is more than 10.0 mg/l.

Geochemistry of petrol pollution is studied in details for the zone of aeration and shallow ground water. This type of pollution is associated with anomalous concentration of sulfur compounds, selenium, nitrates, arsenic and high values of total dissolved solids.

For the adjacent territories risk of pollution was estimated as a function of aquifer vulnerability and hydrodynamic properties. A new Geochemical Aquifer Vulnerability Estimation Leakage Potential (GAVEL) method is proposed. This method is based on the assumption that migration of the pollutants in the unsaturated zone under special conditions is final with depth and time coordinates. Determination of the Point of Migration (PM) was verified by numerical, laboratory, experimental and statistical methods. Statistical – graphical methodology is the easier and not time – consuming. The GAVEL vulnerability classification is proposed, including the risk of probable ground water pollution. This method can be used both for point and regional ground water vulnerability assessment. The GAVEL method was tested for inorganic pollution of unconfined aquifers for two tests – sites located in Moldova and Germany. Present study argues applying of the GAVEL for petrol ground water pollution. This method can be used for express evaluation of the pollution state and for monitoring purposes.

Arrangements for minimization of the pollution of shallow ground water were launched. Clean up of the polluted zones, prophylactic activities and actions of risk minimization has been proposed. Each activity was estimated from ecological and financial point of reference.

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Managing uncertainty in risk maps with application to earthquakes

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The definition of the term risk is given by the product of the consequences of damaging events, such as damage costs and life loss, and the probability of the events occurring during a specified time period [1]. For man-made hazards one might reduce the likelihood of the event, hence reducing the risk; this thus provides the basis for effective risk response. However, in case of natural hazards (earthquakes, land slides, floods), this is not feasible. Therefore, we need to assess the potential impact of any event in order to develop effective responses.

A risk map is a matrix that displays the relationship between the likelihood and consequences of specific risks. They can be used to develop effective responses which minimize the likely casualties, and economic loss in advance of occurrence. In the case of earthquakes, risk maps are obtained from computer simulations of the mathematical models which also incorporate earthquake scenarios. These simulation models typically involve uncertainties in the earthquake location and magnitude, the specification of geological structure (and hence the degree of ground shaking observed between two adjacent sites), and natural variations in the structure between buildings. There are also uncertainties associated with the choice of probability distributions, together with the choices of models used.

Therefore, risk classification (e.g. high, moderate, low risk) given on the risk maps is always associated with uncertainty although this is not indicated by many authors. It is clear that reducing uncertainty of the risk map will lead to more realistic response strategies. Here we make use of the theory given in [2] to reduce the uncertainty of the risk map. We find that the fusion of belief measures on the risk maps reduces uncertainty. This requires multiple disparate sources (independent simulations) to generate risk maps.

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Developments in seismic monitoring for risk reduction

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This paper presents recent state-of-the-art developments and processes (using GPS technology and real-time double-integration) to obtain displacements and, in turn, drift ratios, in real-time or near real-time to meet the needs of the engineering and user community in seismic monitoring and assessing the functionality and damage condition of structures. In all seismic areas, local and state officials and prudent property owners, establish procedures to assess the functionality of buildings and other important structures such as lifelines following a significant seismic event. In most cases, such decisions on functionality and occupancy of a building are based on visual inspections of possible damage to the structure followed by further examination and assessment as to whether the damage condition of the structure presents an unsafe environment for the occupants of that structure.

Alternatively, instrumental measurements of shaking of a building can be used to make informed decisions on the functionality and occupancy of a building following an event.

Drift ratios computed in near real-time, obtained by direct measurements of displacements using GPS or double integration of accelerations using accelerometers, allow technical assessment of the damage condition of a building. Relevant parameters, such as the type of connections and story structural characteristics (including geometry) are used in computing drifts corresponding to several pre-selected threshold stages of damage. Thus, drift ratios determined from real-time monitoring can be compared to pre-computed threshold drift ratios. The approaches described herein can be used for performance evaluation of structures and can be considered as building health-monitoring applications.

Such processes, implemented in three steel frame buildings in San Francisco, California meets the owners' needs for rapid quantitative input to assessments and decisions on post-earthquake occupancy. Low-amplitude data in real-time is readily recorded to routinely analyze and assess the process. Strong shaking data recently recorded indicates that the configured monitoring system with its building specific software can be a useful tool in rapid assessment of buildings and other structures following an earthquake. Such systems can be used as a health monitoring tool, as a method to assess performance based design and analyses procedures, long-term assessment of structural characteristics of a building, and as a possible long-term damage detection tool.

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Risk awareness and climate change

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There is a large gap between the scientific community and the general public in terms of their understanding, awareness and perception of risk due to issues related to climate change. The factors that contribute towards risk awareness are many and complex. At times it is driven by environmental values or political and economic agendas, particularly when the issue is perceived as placing wealth at risk – thus the aversion of oil companies, OPEC nations and the U.S. government towards supporting greenhouse gas reduction measures. Risk awareness and perception is also affected by a number of other important factors such as adherence to particular myths of nature (Adams, 1995). Four fundamental myths of nature[1] as outlined by Adams; nature benign, nature ephemeral, nature perverse/tolerant and nature capricious, are useful in understanding varying attitudes toward how much climate change should concern people. Depending upon which myth or worldview dominates, people will have differing views as to the ability of nature and society to deal future impacts.

Biases in risk perception (Slovic, 2000) are another driver of attitudes. Slovic argues that experts and lay people view risk in fundamentally different ways and that a number of hazard characteristics have important consequences for lay perceptions, including the degree to which a hazard is: voluntary, chronic, common, fatal, known, immediate, controllable or new. Experts typically take a more statistical approach that does not incorporate these issues.

The issue is further complicated because climate change is an example of a problem that fits into what is called post-normal science. For example:

The linkages between science and society are profound.

The problem must be viewed holistically, with consideration of the feedbacks between the climate system, the human system and ecosystems.

With respect to risk there is large uncertainty and a plurality of legitimate perspectives.

The issue is complex and difficult or impossible to fit into a traditional linear problem-solving model.

This particularly affects risk awareness by creating uncertainly and a broad variety of perspectives that achieve legitimacy within the social discourse.

The climate change problem is an example of the tragedy of the commons (Hardin, 1968) acted out on a global scale. Hardin's argument can be summarized with his comment that "*Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons.*" It is likely that this disconnect between individual and collective risk is a fundamental driver of the climate change problem, in terms of how to respond. It is not a rational decision for most individuals to take actions to reduce risk from climate change in the absence of collective action. Yet collective action is extraordinarily difficult to achieve. This is further complicated since the benefits of risk reduction will fall primarily upon future generations. Values related to inter-generational equity thus become fundamentally important as to how risk is perceived.

[1] More complex models have evolved from the field of ecology (Gunderson and Holling, 2002) in their efforts to develop a more general theory of adaptive change.

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Thus risk awareness is complex, very diverse amongst different sectors and interest groups, and subject to inherent biases. It is not surprising, therefore, that the public discourse, often ridden by poor communication, misinformation and unstated assumptions is confusing to many and frustrating for environmentalists and climate scientists. This paper will overview some of the issues that affect risk awareness with respect to climate change and what their impact has been on people's attitudes.

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Postal anthrax, United States, 2001: Delivering risk communications in times of crisis

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In the aftermath of the September 11, 2001 attack on the World Trade Center, concern about further terrorist attacks, perhaps with a biological weapon, became widespread in the United States. Diagnosis of inhalational anthrax in a Florida news photograph editor in early October increased the level of alarm, but the source of this patient's infection remained a mystery until mid-October. On October 15, the receipt of a letter containing a powder preparation of *Bacillus anthracis* spores at the Washington office of a United States Senator led to the recognition of a bioterrorist attack via the United States Postal Service.

The postal anthrax attacks directly resulted in 22 anthrax cases (11 inhalational and 11 cutaneous) and the recommendation of post-exposure antibiotic prophylaxis for about 10,000 individuals who had possible exposure to the powdered agent. Victims included employees of news outlets, United States Senators and their staffs, postal workers, emergency responders, investigative personnel, and private citizens. In addition, a major segment of the general public had significant concerns about the problem and took actions such as taking precautions in opening their mail and obtaining antibiotics.

Forensic investigations documented that a specific strain of *B. anthracis* was involved, that the terrorist(s) had prepared a surprisingly sophisticated fine particle powder containing anthrax spores, and the spores could escape sealed envelopes and contaminate the environments through which the letters passed during processing and delivery. Even the route followed by some letters through the postal system as well as the time frame when they were at specific locations was determined with a surprising degree of certainty. However, the identity and motivation of the perpetrator(s) remains a mystery.

The challenges of managing effective risk response during this event were related to a high degree of uncertainty about essentially all facets of the problem. The unfamiliar threat, the lethal nature of the disease, the need for rapid response, the large number of potential victims, an unidentified perpetrator with unclear motives, lack of a solid knowledge base for making risk assumptions, limited response resources, wide-spread public concerns, political pressures, non-stop news coverage featuring experts with conflicting opinions, and threatened disruption of the postal system were some of the factors coming together to form a perfect storm for the risk communicators.

The postal anthrax incident has been selected to illustrate crisis and emergency risk communications. In this type of communication, information is provided to the target audience to allow them to make the best decision for their personal well being in the limited time frame posed by a suddenly emergent crisis. The decision may have to be made with imperfect information, may be irreversible, and carry an uncertain outcome. Even worse, the decision has to be made now.

This presentation will focus on two stakeholder groups: persons who had documented exposure to anthrax spores in their work place and the general public. At four work sites, 5,827 persons were provided with antibiotic prophylaxis, with a recommendation to continue the medications for 60 days. Compliance with the recommendation ranged from 31% to 64% at the four locations. Differences between the sites which may have contributed to the difference in compliance rates will be discussed.

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Persons residing in cities where anthrax cases occurred were more likely to feel at risk of contracting anthrax (14% to 21%) than in the general population (9%). Despite their concerns, most did not panic or undertake preventive procedures which were not reasonable or recommended. Respondents expressed greatest trust in their personal physician as a source of information. Various local officials were considered reliable sources of information by more than 50% of the respondents, with national leaders being considered less reliable. The print and broadcast media devoted a great deal of coverage to the events but were generally responsible. The news coverage included health messages but with less emphasis than public health officials desired. Lessons learned during the postal anthrax incidents has led to modifications in public health approaches to risk communication.

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Fowl pest crisis: stakeholder communication at stake

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This research on the "Fowl Pest Crisis" gave us not only the opportunity to focus on the risk perception and risk communication issues but also to re-consider the concept of "stakeholders". In normal time, crisis planning does identify the potential stakeholders in order to prepare adequate and efficient communication programmes. But lessons learned from the crisis show us a different and unexpected picture of reality. Traditional stakeholders such as veterinarian services, commercial and industrial sectors, farmers, the media and the public are already well known for their involvement in the food chain. But during the fowl pest crisis, it came as a surprise to learn that unexpected groups such as pigeon fancier associations, zoo or public domain with exotic birds were also concerned by the event. Yet, those stakeholders are not used to communicating with public authorities in charge of the food chain and, as a result, resorted to informal and political contacts in order to be heard. Though a better knowledge-in-context of those stakeholders could have been useful, it was not available during the crisis. We develop the notion that, n normal times, "Worldviews Understanding Methods" (WUM) have to be developed by the public authorities in order to prepare better communication procedures when a crisis occurs. WUM could be described as a set of qualitative methods such as focus groups. The main feature of these methods is to gather opinions and worldviews of homogeneous groups of actors. WUM are not only effective tools to learn more about the stakeholders' views but also ways to build confidence with public authorities.

During the fowl pest crisis, we also learned that specific groups of stakeholders were very closed to each other from a commercial or political point of views. However, some of the stakeholders involved from the outset (farmers, carriers, pigeons fancier associations…) tried as much as possible to escape the decision taken by the federal agency. This "resistance" phenomenon was only made possible with the help of other stakeholders such as veterinary surgeons or politicians. Their response to the risk had local and short-term scales because of the nature of their relationships. By contrast, the relationships between the food agency and stakeholders such as farmers, carriers or pigeon fancier associations are more authoritarian and based on global and long-term scales. Therefore, the effectiveness of the decisions taken by the food agency is closely linked to its degree of "social penetration". In other words, as long as stakeholders perceive the food agency as very far from the local context, they will resist.

During a food crisis, "resistance" is also the result of a high level of scientific uncertainty. Communicating with the stakeholders about this uncertainty is a very difficult task especially when a particular stakeholder (the media, for example) wants to have the information in priority. The ability to provide the information quickly is therefore essential as media are used to put all the stakeholders under pressure in order to "produce" information.

Eventually, how can risk communication be improved? First of all, a better communication system should be built on a better knowledge-in-context of potential stakeholders. Secondly, public authorities in charge of risk response systems have to change their relationships with the stakeholders in terms of local community. Thirdly, up-to-date information has to be available for all stakeholders without any kind of priority.

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Crisis and emergency risk communication: by leaders for leaders.

Be first. Be right. Be credible.

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Crises can assault a community in an instant or creep slowly into its midst randomly wreaking havoc until it has the community firmly in its grip. Conventional explosions, category-5 hurricanes, chemical releases, shooting sprees, deadly disease outbreaks, 500-year floods, dirty bombs, nuclear bombs, fertilizer bombs, earthquakes, blazing brush fires, infrastructure collapses, and raging tornadoes are just some of the disasters that threaten somewhere at sometime and are, ultimately, outside an organization's control (Mitroff, 2004). Leaders do control, however, how well their communities respond and recover from the disasters they suffer. As a leader in a crisis one can have a real, measurable affect on the wellbeing of one's community through the words said and the speed and sincerity with which the leader says them. Research indicates that, in natural disasters, the public perceives the success of the operational response by the speed and amount of relevant information they receive from the emergency response officials (Fisher, 1998).

Communicating in a crisis is different (Reynolds, 2002). A leader should know that the way he or she normally communicates with the community may not be effective during and after it suffers a crisis. Crisis and emergency-risk communications (CERC) are fully legitimate tools of response and recovery just like any other resource applied to the disaster. It is not an attempt at mass mental therapy. It is a reasoned and mature communication approach to the selection of message, messenger, and method of delivery.

The U.S. Centers for Disease Control and Prevention's (CDC) training gives leaders the tools to navigate the harsh realities of speaking to the public, media, partners and stakeholders during an intense public-safety emergency, including terrorism. In a crisis, the right message at the right time is a "resource multiplier"—it helps response officials get their job done. Many of the predictable harmful individual and community behaviors can be mitigated with effective crisis and emergency risk communication. Each crisis will carry its own psychological baggage. A leader must anticipate what mental stresses the population will be experiencing and apply appropriate communication strategies to attempt to manage these stresses in the population. The CDC training and course materials explore the following: the psychology of communicating in a crisis, the role of spokesperson, working with the media during a crisis, and public health and media law. Included in this training are excerpts from interviews so that a leader can hear directly from leaders—governors, mayors, health officials, and fire chiefs--who stepped up to the microphone during crises and faced their community and the world. One can learn how they made tough decisions about how to inform, console and motivate their constituents during and after the crisis.

"All I Need Is the Air That I Breathe…" - Risk Perspectives on the Health Impacts from Coal-Fired Power Generating Stations in Alberta, Canada

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Residents in the area around Lake Wabamun (west of Edmonton, Alberta) have raised concerns about potential health impacts from four nearby coal-fired power generating stations. The Wabamun and Area Community Exposure and Health Effects Assessment Program (WACEHEAP) is being developed by Capital Health and Alberta Health and Wellness to look specifically at what people are being exposed to in this area and what are some of the health effects from these exposures. A risk communication strategy for this program, involving a diversity of interested and affected parties (including active community groups and a First Nation community), was developed.

The first step in the strategy was to better understand community concerns, communication and information needs, and desire for involvement. A random telephone survey was conducted of 403 people in the study area in July, 2003 to collect this information. A second self-administered survey of 29 concerned citizens was conducted in the fall of 2003.

Results from the random survey indicated that 18% of respondents had health concerns from living in the area, and that these were primarily attributed to the air emissions from the power plants. However, 60% of respondents felt there were health benefits to living in the area, with the majority indicating that the major benefit was cleaner air. Approximately one-third of those with health concerns had raised these to government, and most (68%) were not satisfied with the response. The results from the targeted self-administered survey were different in many aspects from the larger random survey, and provide an interesting comparison of survey types. The results of both surveys offer insights into different community concerns and information needs, and have ultimately resulted in improvement of the risk communication strategy.

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Vulnerability models and social indicators for crises forecasts

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Professional vulnerability analysts do not agree on how key terms should be defined, but for the purpose of discussion, this report uses the following specific definitions. In the context of environmental issues, "risk" is defined as the probability of occurrence of a particular adverse effect on human health or the environment as a result of exposure to a "hazard", which may be a hazardous chemical in the environment, a natural hazard, or a hazardous technology. "Vulnerability assessment" refers to a formal or informal procedure producing a quantitative estimate of environmental and social vulnerability. For example, risk assessment is often used to estimate the expected rate of illness or death in a population exposed to a hazardous chemical. "Risk analysis" is used more broadly to include quantitative and qualitative

Opponents of vulnerability management based on relative risks and risk reduction potential contend that comparative risk analysis in an unscientific, ad hoc procedure that lends a false air of objectivity to the subjective judgments of scientists. Opponents question whether an exercise that combines the diverse views of an unrepresentative sample of government scientists to produce a single prioritized list of hazards is more informative than a thorough recitation of the points on which scientists with diverse viewpoints agree and disagree, such as may occur in a hearing or an advisory committee.

Socio-environmental assessment is a relatively new and immature field; this is evident in the state of development of its analytic methods for assessing exposure levels and their potential adverse effects. Current methods of estimating human or ecological exposure levels generally focus on individual hazards and isolated incidents or constant long-term exposures. Therefore, they inadequately account for common, real-life conditions, such as fluctuating exposures to multiple crises. The most developed and well established methods of estimating potential adverse effects probably are those used to analyze acute social effects of high short-term risks. Methods also are fairly well developed for assessing human risks in networks. These methods evaluate and model the results of societal studies to estimate social capital.

There are at least four ways to promote the development and use of the best available methods for vulnerability analysis; peer review, research and training, oversight, and provision of guidelines.

Efforts to modify the regulatory process have generally focused on the following ten areas: (1) use of cost-benefit analysis and cost-effectiveness analysis when developing regulations (2) use of risk assessment analysis to determine the probability of certain hazards occurring and their adverse effects; (3) use of a regulatory budget to provide an overview of regulatory costs and set a cap on those costs; (4) subjecting new regulations to review and possible disapproval them (5) widening the scope of judicial review of regulatory actions; (6) imposing a moratorium on new regulations while agencies review their existing regulations to determine if they should be revised or abolished; (7) reducing and streamlining the paperwork required by regulations; (8) establishing a fair procedure for compensation of property owners when all or some of their property is "taken" by a regulatory action; (9) establishing a sunset mechanism whereby regulations or regulatory programs are terminated unless agencies determine otherwise; and (10) restricting mandates imposed on state and local governments unless federal funds are provided to offset the costs of those mandates. Each of the areas is briefly discussed in the paper.

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From technical solutions to the ecological aspects: The changing flood protection methods in Hungary after the frequent flood in Tisza River 1998-2001

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Faced with increasing losses, the Hungarian government is concerned about continuing its tradition of taking almost full responsibility for flood risk management, including flood prevention, response, relief and public infrastructure repair. The central government has invested huge sums in a vast network of protective levees, including about 3000 kilometers of levees along the Tisza River. This levee system is proving insufficient against worsening flood conditions, and it is expensive to maintain. Moreover, there are value conflicts: for example, whether to continue protecting the residents of high-risk areas with levees or to re-naturalize the river to enhance the ecosystem. The central government accelerated its levee-construction program for the Upper-Tisza River and its tributaries in 1998. Following the levee breach of March 2001, the insufficiency of this programme was widely recognized, and the government has begun discussing other flood-mitigation measures, including the construction of emergency reservoirs in Hungary and upstream Ukraine, increasing the capacity of the main riverbed, and changing land-use practices in the flood plains.

Difficulties in preventing damage are caused by the lack of information and the passivity of the population. Information and mobilisation can be realised more efficiently through the local networks of communications and cooperation.

Instead of the 'command' model of the communication of risk the model of 'capacity-building' is more effective. The population knows little of the Vásárhelyi Plan as yet, but the elite groups are already much better informed. The population expects increasing safety, growing tourism and job creation from the realisation of the Plan.

The elite primarily expect the development of the infrastructure from the implementation of the Vásárhelyi Plan.

In case of the acceptance of any professional programme in relation to the Further Development of the Vásárhelyi Plan the inhabitants of the region must be continuously informed. The most acceptable solution needs to be developed during the course of conciliatory talks. Research results show that no 'good solution' is possible without compensation.

Since the 2001 catastrophic flood of the Tisza River was not followed by others, we were interested primarily in finding out if there were any changes in attitudes to flood risk management strategies as we got further away – both in time and space - from the 2001 catastrophe.

Considering the long-standing tradition of the central government providing comprehensive flood protection throughout Hungary's extensive flood plains, the strong minority views supporting more individual initiative and ecological alternatives are significant. They are also policy relevant given the government's intent to reduce its budget deficit as a condition for European Union membership. These insights have formed the basis for developing policy scenarios as input to a catastrophe model of the region.

The presentation will be drawn the most important stations of this changing in the water management policy and its public acceptance.

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Flood defence in Romania – past, present and future

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Amongst natural phenomena that create victims and have negative consequences for human activities, flooding is the worst, due to both to its magnitude and frequency. Romania has a well developed hydrographical network of about 70,000 km watercourses. An important characteristic of these rivers is the periodical occurrence of high-floods due to the snow melting, heavy rains or the conflation of both phenomena. From analysis of flood frequency data, high-floods are seen to occur most commonly in spring and less in autumn or winter. The torrential character of high-floods is the main these rivers.

The earliest inundations in Romania were recorded on the Danube river in 1234/1235 and 1267/1268. In the next centuries there were 58 major floods, and documents from the first half of XIX-th Century record their description, causes, development, impacts and even registered levels. The need for flood defence measures led to the construction of hydrological stations (the first one in Orsova in 1838). After 1854 the first meteorological observations are made in Iasi, and in 1884 the Meteorological Service in Romania was founded. In 1924 the first Water Law was passed, including with elements of hydrology and river planning. In 1925 the water management based on hydrographical basins was initiated.

The first national programme of catchment development in Romania was approved in 1976 following the catastrophic floods that occurred in 1970 and 1975 across large areas (50,000 sq km in 1970 and 60,000 sq km in 1975). This established unitary water resources administrations, in order better to manage the catchments. Since then, also, many hydraulic structures have been built in order to control peak flow, including reservoirs, high water storage areas, riverbed improvement and embankments.

Despite this, floods continue to be a real danger, generating huge damages. There is and will be a permanent risk. Attempts to reduce the magnitude of high-flood events by structural means have had a limited effect and it is necessary that flood defence should be based in the future on non-structural measures. This means the improvement of warning systems, hydrological forecasts and information dissemination together with a better knowledge of flood risk, the discouragement to build in floodplain areas, improvement of legal framework for responsible institutions, development of adequate economic instruments and, last but not least, population involvement and awareness for flood defence activity.

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Avian infectious diseases in the Republic of Moldova

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The avian industry is one of the most profitable branches of the biotechnology in the Republic of Moldova. This has developed because of the strong interest of the population in avian products.

The avian industry has special importance because it creates of favorable epizootic conditions for infectious diseases. To control risks associated with these conditions, close supervision is needed of the bird's area, using laboratory investigations of birds from individual areas and of those in industrial environments, especially in relation to diseases such as influenza, Newcastle disease, Fowl Cholera et al.

Currently, the avian industry experiences high economic losses because of infectious diseases including Infectious Bursal disease, Egg Drop Syndrome, Infectious Bronchitis, in the mass avian raising conditions and Pullorum disease, Newcastle disease, Fowl Cholera in the individual growing area. As a prophylaxis and to combat diseases, a schedule of vaccination is used. The successful of this strategy, however, depends on the reliability of laboratory procedures and equipment, which need radical improvement.

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