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# BIRD STRIKES RISK POLICY STRATEGIES: PROPOSAL FOR A RISK CLASSIFICATION SCHEME

By

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**Abstract**

This study, presents a classification scheme based on two main factors: the potential consequences in bird strikes hazards (outcomes, losses, damages) and the uncertainties about consequences in parallel with the examination of a classification specifically directed at accident risk with the dimensions closeness to hazard and level authority i.e. airport operator, pilots, municipalities which are adjacent to airport, stakeholders etc.

The classification systems provide a knowledge base for structuring bird strikes' risk problems, risk policies and class-specific management strategies. Simultaneously in this study, three major management categories have been applied: risk – based, precautionary and discursive strategy. The risk – based policy means treatment of risk – avoidance, reduction, transfer and retention – using risk and decision analyses. The precautionary strategy means a policy of containment, constant monitoring, continuous research and the development of substitutes. Increasing resilience, i.e. resistance and robustness to surprises, is covered by the risk based strategy and the precautionary strategy. The discursive strategy means measures to build confidence and trustworthiness, through reduction of uncertainties, in air accidents and mishaps are caused by bird strikes, clarification of facts, involved human factors, deliberation and accountability. Nevertheless, in most cases, the appropriate strategy is a mixture of these strategies.

**Keywords:** Bird Strikes, Risk Based Policy, Precautionary Strategy, Discursive Strategy and Stakeholders.

## 1. Introduction

Every day we face decisions that carry an element of risk and uncertainty. The ability to analyze, communicate and control the level of risk entailed by the decisions remains one of the most pressing challenges to the analyst, scientist and manager such as it happened with whom are involved in bird strike problem.

There is a number of decision situations where risk and uncertainty, in bird strikes problem, need to be addressed. In this paper we look at some structures, or classification schemes, for these decision situations that are consistent with our predictive approach.

Based on these Classification schemes, we will discuss the use of risk and uncertainty analyses, formal decision analyses and risk management policies.

However, when establishing principles and methods, we have of course examined descriptive theory and results reported in the literature and used our experience from real life. The aim of this study is to establish a structure for decision making that produces good decisions or improved decisions, defined in a suitable way, based on a realistic view of how people can act in practice regarding the bird strikes' problem (Klinke & Renn, 2001).

This study discusses the use of risk analyses as a tool for decision making and it touches on aspects of risk treatment, risk acceptance and risk communication. Risk treatment is the process and implementation of measures to modify risk, including measures to avoid, reduce (optimize), transfer or retain risk. Risk transfer means sharing with another party the benefit or loss associated with the bird strike risk, which is typically effected through insurance without that means that is the only way.

The many challenges for a civil aviation organization or other related to bird strikes' problem organizations, related to define objectives, to avoid, reduce transfer and retain bird strike risks we just briefly look into. Thus the various disciplines and application areas need to define their own risk management system, tailored to the specific situations of interest in each country and, of course, in each aerodrome.

The terminology used in this study is largely in line with ISO standard on risk management terminology (ISO, 2002).

## 2. Qualitative Definition of Increased Risk

This classification scheme is based on two main factors: potential consequences (outcomes, losses, damages) and our uncertainties about consequences; in other words, the key factors related to our qualitative, broad definition risk. From these two factors it's established the seven categories in Table 1. These seven categories show a tendency of increased risk, level of authority involved, stakeholders' implications and treatment of societal values. The arrows should be read as tendencies and not as strictly increasing values

**TABLE 1**

Risk context classification scheme: read the arrows as tendencies, not as strictly increasing values; S = small, M = moderate, L = large

| | CATEGORY | | Level of risk | Level of authority involved | Stakeholders implication | Treatment of social values |
|---|---|---|---|---|---|---|
| | Potential consequences | Uncertainties of consequences | | | | |
| 1 | S | S/M/L | Low | Low | Low | Low |
| 2 | M | S | ↓ | ↓ | ↓ | ↓ |
| 3 | M | M | | | | |
| 4 | M | L | | | | |
| 5 | L | S | | | | |
| 6 | L | M | | | | |
| 7 | L | L | High | High | High | High |

To further characterize the consequence potential beyond straightforward summarizing measures related to losses and damages such as economic loss of a commercial aviation enterprise (direct cost such as fuels, spare parts etc and indirect cost such as downtime, effect on enterprise's aircraft availability, rumor of enterprise and so on) and number of fatalities, we relate it to these factors:

- *Ubiquity* is the geographic dispersion of potential damages. In the bird strikes case we are usually concerned about the airport area and an area of about 8 – 13 km around the airport within, according to the ICAO data, occurred the majority of bird strike accidents.
- *Persistency* is the temporal extension of potential damage. For instant in some areas in association with bird species and behavior of them, we have augmented problems during the early autumn or late spring.
- *Reversibility* is the possibility of restoring the situation to the state before the damage occurred. That has a close connection with the precautionary principle and the proximity principle of sustainable development concept. For instant how can we manage the agricultural farms which are adjacent to airport and functioned as attractors to birds?
- *Delay effect* characterizes a long time of latency between the initial event and the actual impact of damage.
- *Potential of mobilization* means violation of individual, social or cultural interests and values generating social conflicts and psychological reactions by individuals and groups who feel afflicted by the risk consequences. This factor concerns the customers of an aviation enterprise, the farmers who cultivate next to airport, airport operator and adjacent municipal authorities' conflicts since in most of the E.U. countries there isn't a concrete legal

framework or even ad hoc by acts, the E.U. Common Agriculture Policy, the Municipal Sanitary Policy etc.

And to further characterize the uncertainties we relate them to these factors

- The degree of predictability. Apart from general temporal or spatial predictions about bird activity, we don't have precise statistical data since we haven't establish monitoring projects in real time, in the majority of airports.
- The difficulty in establishing appropriate (representative) performance measures (observable quantities on high system level). For instant in many airports, there haven't done appropriate environmental impact assessments even afterward the construction of airports.
- Persons or groups who assess or perceive the uncertainties. In this category belong airport operators, pilots, wildlife managers etc.

Depending in how the problem relates to these factors, different risk policies and management strategies would be required. Thus there is more than one policy and more than one management strategy associated with each of seven categories. Now we describe and discuss the first category of the above classification scheme which is usually more suitable with the common occurred bird strike risk, using the headings in Table 1.

**2.1 Small + small/moderate/large**

This category is characterized by situations where the potential for loss or damage is small and the uncertainties related to the consequences are small, moderate or large. There is typically an established practice for the activities. Note that the term "small" is a relative concept. An injury or fatality is not a small consequence. In these situations we would pay attention to risks and uncertainties, perform simple qualitative risk analyses, increase robustness in the case of an accident and look for substitutes. In these cases a formal risk management system for the specific situation is not be introduced or ignored.

This classification system provides a structure for categorizing situations or problems according to potential consequences and uncertainty. These dimensions characterize the situation or problem to some extent but the definition of a policy and a management strategy needs to take account of other factors, as discussed above. This is an essential point. Risk management is more than expert assessments of uncertainty and risks. We cannot base our decisions on the results of risk and decision analyses alone. In practice we need to find the proper balance between risk - based strategies and precaution and discursive strategies.

The above classification structure, with adjusted characterizations of potential consequences and uncertainty, can also applied in a project risk context to

identify a list of critical activities and issues that need to be followed up during the project i.e. management functions related to wildlife factors at or in the vicinity of the airport, bird control, mammal control, management of habitats and food sources on airport property as well as land uses and food sources off airport property, potentially related to wildlife hazards at the airport. The scheme can become a tool in the uncertainty management of the project.

## 3. Proximity to Bird Hazard and Level of Authority

Many actors inside and outside an organization are in a way or another involved in dealing with risk. For example in bird strikes situations are directly involved the airport operator, the patrol airport team, the wildlife manager, the control tower staff and the pilots except the indirectly involved bodies such as farmers, municipal authorities, Ministry of Transportations and Communications, Ministry of Environment and Public Works etc.. Decisions involving uncertainty and risk are made at different organizational level and in a manner of settings. Wildlife managers encounter situations which force them to make decisions that seriously affect flight operation goals and accident risk in a conflicting manner.

To make satisfactory decisions, they are dependent on decisions by airport operator, e.g. in the form of policy statements about priorities of accident risk versus airport operation goals. Regulatory agencies can be seen to make decisions when imposing new requirements, e.g. to perform risk analysis and deal with bird strike risk in specific ways. It's obvious that the context and nature of these decisions processes varies significantly. Often decision – makers are constrained in a way that does not allow them to assess risk in detail.

The time and resources available for the decision normally restrict the degree of modeling and refinement in the analysis. Even more important, formal risk analysis is associated with procedures and work environment settings, which do not conform to all kinds of decision settings (Klinke & Renn, 2001). It's obvious that airport operator, with high and diversified workload, in many cases may not be able to perform structures risk analysis over environmental releases for a number of decision alternatives. Such constraints in the real world may have implications for normative frameworks for application of bird strike risk analysis and management such as guidelines, standards and regulations. When should risk analysis be carried out before a decision is made, what form should it take and how should it be documented? With regard to the decision, additional questions arise: How should alternative attributes be valued? Obviously, different actors have different roles in bird risk management.

The roles and the character of bird risk handling are closely linked to the decision settings. In this paper it's presented a typology of decision settings, paying special attention to constraints and the potential for bird risk analysis and manage-

ment. The classification is based on two dimensions: closeness to hazard and level of authority. It identifies decision settings that are typical for certain groups of actors at and in the vicinity of an airport and it discusses the appropriate constraints for decision makers or actors with respect to bird risk analysis and management and it shows the need for interaction among actors in different decision settings.

### 3.1 Characterization of decision settings

Figure 1 presents the two dimensional taxonomy for categorizing decision settings. We think of proximity to bird hazard primarily in terms of physical distance and time. This implies that pilots, aircraft line maintenance personnel and patrol team usually find themselves at the sharp end, i.e. close to the hazard source. Designers, planners, airport operators, wildlife managers and regulatory institutions typically operate at the blunt end. Some actors may be operationally close to the hazard source, even though they are physically remote, for instance air traffic control operators. We will consider these actors as belonging to the sharp end even though they are less vulnerable in the case of a bird strike.

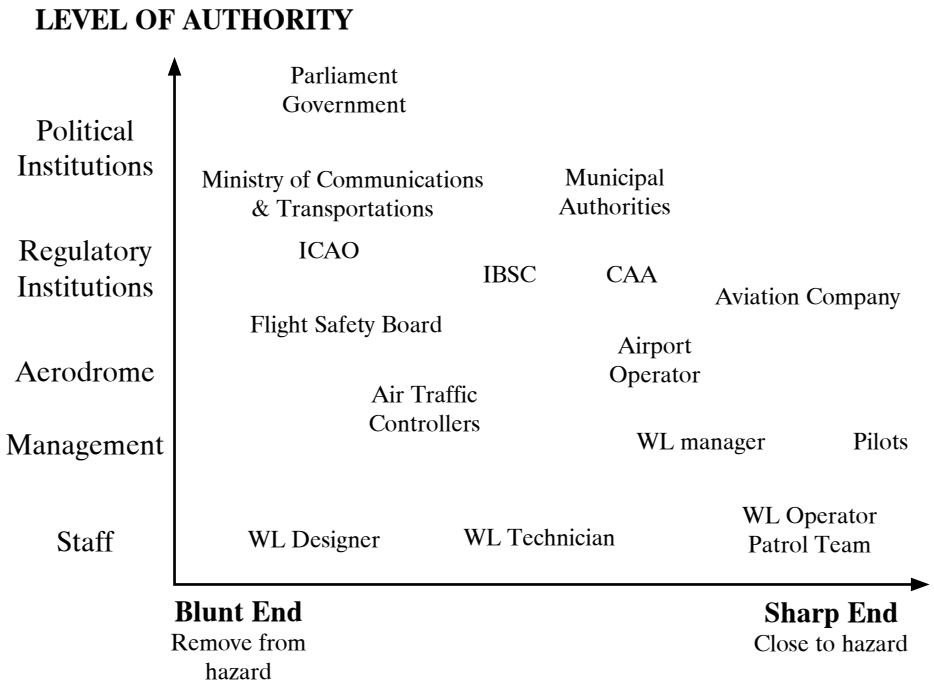


**Figure 1:** Two dimensions for characterizing settings for safety - related decision making, regarding bird strikes: ICAO = International Civil Aviation Organization, IBSC = International Bird Strikes Committee, CAA = Civil Aviation Authority.

Actors at the sharp end are mostly even driven and thus operate within a shorter time horizon for most of the time. We also expect actors at the sharp end to have more updated and detailed hands – on knowledge of the system they operate than actors at the blunt end (Kristensen *et.al.*, 2003).

Level of authority is conceived primarily in formal terms. Actor A has higher level of authority than actor B if actor A is entitled to give directives, orders or instructions to actor B but not vice versa. This does not necessary imply that actor B is unable to exert power over actor A. Airport operators may, for instance, work through municipal political channels to exert pressure on a regulatory institution and influence local standards and regulations.

The conditions under which actors make decisions strongly influence the decision processes which lead up to the decisions or to the way action is taken. We thus expect decision criteria, procedures and outcomes to be related to 1) how close an actor or decision forum is to the hazard and 2) the level of authority of the actor or forum. These relationships are complex, since decision makers also adapt to circumstances not covered by these two dimensions. But even a grossly simplified model of these relationships may be helpful in sensitizing us to the way decision makers adapt their setting. Figure 2 shows a classification scheme based on five distinct decision settings.

When reviewing the various decision classes, we also discuss the implication for bird risk analysis and management and how risk can be dealt with an appropriate manner, acknowledging that not all actors can collect information and model the world in detail before making a decision (Rasmussen, 1997).

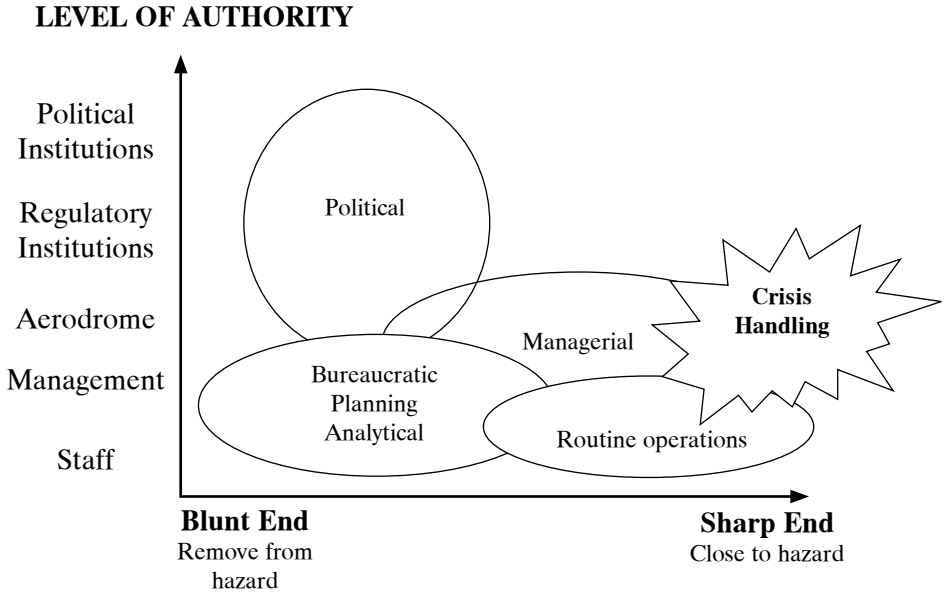


**Figure 2:** Classification of decision settings

### *3.1.1 Routine operational risk*

Let us first view decision making in an operational environment of an airport, characterized by the sharp end and low to medium authority. In this setting, action is not always the result of decisions, in the sense of conscious deliberations or analysis and choice of action. The most common such setting is the three modes of activity generation from received information: skill based, rule based and knowledge based.

Skill based behavior such as the behavior of an airfield worker with regard to bird strike prevention, is characterized by direct interaction between humans and their environment in an automated, feed forward control mode. It differs from rule based or knowledge based behavior in that it doesn't relate to a problem but translates information through a mental model into actions.

Rule based behavior relates to a problem in a standard if X takes a certain value x, then apply action d, rule type manner. It relies on a repertoire of rules embedded in the decision maker or the actor (e.g. airport operator). In this sense it's a problem solving activity; information is related to the presence of a problem. For successful application of a rule based strategy, its characteristic that the problem encountered is matched by an adequate rule. Otherwise the output of applying a rule is generated through induction from specific experience and mental modeling to generalizations about appropriate reactions. Skill

and rules can be conceptualized as pre-programmed solutions and contingency plans in an aerodrome. Both cases generate a more or less automated response (i.e. airport operator or wildlife patrol team) to changes in an observed world.

Knowledge based behavior in operational decision settings occurs when a problem is not addressed by the rule inventory, or when rules are broadly defined. It is a different form of problem solving than rule based action as it involves analytic processes and prediction and it concerns especially airport wildlife managers. Contrary to rule based problem solving, knowledge based solving is characteristic for situations where the problem is not well defined beforehand. For instance, there are many airports where are applied bird dispersal miscellaneous or not techniques without to be done before an ad hoc, specific, environmental impact assessment about certain bird species or land uses/cover (rule based behavior). There are just implemented a directive either an advisory circular or a policy statement or a Certalert which are usually ineffective.

Rules can be implicit and systems can have implicit reliance on rules. If safety relies on application of skills and rules, they often need to be formalized. In heavily regulated environments, e.g. aviation, reliance on explicit rules is strong. Moreover that is the reason because when a pilot and especially a pilot of a civil aircraft where the rules are more standardized, is on route difficulty can avoid an imminent bird strike.

Generally speaking, the airport manager will not refer to a model to make predictions about the effect on higher level attributes; they will not be uncertain about these. The manager or operator has observed a value x, which is certain. As long as there is a rule-which is deterministic-uncertainly is not an issue for the decision maker at the sharp end. Formalized based action in risk sensitive environments will involve risk analysis. This does not imply that risk is not an issue at the sharp end. It's only recognition of the fact that sharp end behavior is governed by responses to sensory inputs which are predetermined and assume determinism between action and response.

Consequences of alternative decisions in response system behavior need to be assessed beforehand and strategies or detailed rules for behavior need to be pre-programmed. The "elsewhere" can be viewed as a design assessment context? This is a typical blunt – end setting where the available timescales and resources allow data collection and analysis.

The ideas presented here do not imply that such analyses have to be performed by a completely different category of people. The process of designing appropriate responses or decisions, depend on experience transfer from the sharp end operational knowledge base. It appears quite sensible, even man-

datory, that personnel from operations in the airfield are involved in the risk analysis and preprogramming of decisions.

However there are some practical limits in such complex and dynamic environments as an aerodrome. It may not be feasible to foresee all contingencies and sharp – end personnel and especially airport operators may not accept being programmed by "outsiders" such as wildlife managers in terms of bird strikes' prevention. Moreover the problem seems to be more serious when we have to cope with National Air Force officers and pilots or e.g. with the commanders of squadrons or headquarters of air force flight safety department. In these situations a more sensible approach may be to provide airport operators with information on the boundaries of safe performance. The point is not to specify how the operator is to perform the job but rather to show the boundary between safe and unsafe ways to do the job (Rasmussen, 1997).

### *3.1.2 Management of risk*

Management decisions, in the sense of unprogrammed decisions, can be associated with actors and decision settings at a high level of organizational authority and at the same time be somewhat removed from the sources of bird hazard. Examples are flight safety boards, airport managers, wildlife executives and managers or civil aviation authority's directors. Managers at this level could have typically up to 50 active problems to deal with at any given time. Studies of decision behavior show that actors, constrained by their information processing capacity, will often apply a satisfying strategy when making decisions. This implies that they look for a decision option, which is good enough according to some aspiration level. Managers make many decisions without reference to anticipated consequences, but in accordance with rules and codes of conduct. This is seen as a simplification of decision – making based on successful previous applications. However, decisions involving major risks cannot be dealt with on the basis of prior experience. Rules of conduct (i.e. mandatory, ICAO directives etc) for such decisions must therefore refer to uncertainty about future events, i.e. risk, which cannot be deduced solely from historical experience, as often that experience does not exist or is rather limited. From problems which involve large risks (at seasons with augmented bird activity), managers will often choose to delegate all responsibility for the design phase to analytical functions; here "design phase" means development of alternatives, analysis of consequence and risk and development of a recommendation for a decision. Analytical functions can be interpreted as actors in a less exposed decision setting and at lower level of decision. This coincides with an analytical, bureaucratic decision setting, see Figure 2.

When risk analysis is carried out, the management decisions maker's risk assessment involves a more or less detailed assessment of the results of the risk

and uncertainty analysis prepared by the experts and analysts i.e. wildlife managers. In our terminology this would coincide with a review of the scientific predictions (if there are), the associated uncertainty assessments and the relevant background information (statistical analyses, past bird strikes official reports etc). Also if a formal decision analysis, for example a cost-benefit analysis, is performed, there is a need for review and judgment process to choose the best decision alternatives (this is recommended especially in military flight operations since at civil airports there is a formal flight schedule). Although many airport managers would apply a satisfying regime and use off – the – self standards in many situations, there is now wide acceptance for using a risk – based (informed) approach in bird strike situations involving high consequences and large uncertainties.

### *3.1.3 Political management of risk*

Governmental and governmental agency decision making is reflected in laws and regulations. Such decision actors or forums deal with at high levels of authority and are far removed from safety bird hazards sources. The dominating decision – making processes in these settings are political or negotiate, supported by bureaucratic processing. The dominating constraint on these processes is conflicts among stakeholders. The dominant decision criterion is thus to obtain the degree of consensus necessary to conclude the decision process. Such decisions should be seen less as solutions to well – defined problems and more as results of compromise, conflict and confusion through bargaining among actors with diverse interests. Many major decisions in national or international standardization forums (e.g. the International Civil Aviation Organization) are made in this decision mode, in a discursive manner, similar to political decisions. With consensus as a major, albeit implicit, decision criterion, it's not meaningful to talk about optimal decisions in a conventional sense. The "consensus" is part of the "optimality" criterion. Moreover, changing coalitions may lead to inconsistencies of preferences with time.

We have assigned highly structured bureaucratic and political processes as well as open-ended or even chaotic political processes to a single class because bureaucratic and political decision processes are often tightly interwoven in practice. Political decisions are usually prepared and implemented by bureaucracies, and bureaucratic decisions may be appealed to political forums or deflected by actors working through political channels.

Due to difficulties in achieving consensus on major changes from an existing platform, for instance landfills location, recycling operations, agricultural permits, fees, licensing, banning or definition of buffer zones adjacent to airports, many political and bureaucratic decision processes come close to the so-called

incremental muddling through paradigm in which actors build policy gradually through minor decisions based on limited analysis.

Uncertainty and risk analyses are requisite instruments in political decision-making. They are designed to support the political decision by assessing consequences from a possible bird strike, for alternative decision option and evaluation of consequences and risk against presumptive values and preferences.

Uncertainty and risk assessment should have an important place in informing public policy makers. As for managerial decisions, the decision makers should be informed about predicted consequences and the risk of uncertainty assessments. Considering the common lack of agreement by the political actors regarding the importance put on issues and objectives, care should be shown when using formal decision analysis. Such analyses should be used as decision aids, stressing that the value judgment adopted are used to produce insights and not hard recommendations.

### *3.1.4 Bureaucratic management of risk*

In blunt end settings, remote from immediate bird hazard and with no direct executive authority, we find actions like design, engineering and planning, as well as controlling and analytical functions e.g. bureaus of Civil Aviation Authorities. Actors in such functions are usually not forced to make decisions at the pace of executives. Their resources for information processing (e.g. time, calculation tools, data) tend to be relative abundant. This often allows them to seek decision options, analyze and evaluate them and find the alternative that optimizes some criterion (e.g. in a cost benefit analysis) under the given constraints. The groups of actors and organizational functions falling into this setting are large and heterogeneous with respect to the nature of work and decisions. For some, the focus will be to make routine decisions, very similar to those described under operations but more detached from hazards. Other functions are more supporting functions for decisions at higher level.

In this category there are usually three areas of involvement in risk management of bird strikes

1) Decisions made on the actors' own account. Although actors in the bureaucratic domain tend to have more time, information and information processing resources than actors in other domains, this does not imply that optimization will be the dominant decision mode. These decisions will on many occasions be made by following rules, mandatory, directives of I.C.A.O. or through satisfying predetermined criteria. A designer has to relate to constraints of cost, the flight schedule, the customers' service, the wildlife hazards' mitigation, reliable operations etc. The designer and his superior, normally a middle manager with limited overall authority, can be expected to analyze and judge one alternative

against the local requirements e.g. Local and Peripheral Authorities' design and decisions, land uses, developing trends of the area, wildlife refuges adjacent to airports etc. Therefore, seldom will an overall optimization or an integrated risk analysis and evaluation take place. In terms of decision and risk analysis, the setting is more of a satisfying regime than an optimization regime. Optimization requires parallel analysis and evaluation of relevant alternatives, i.e. more than one alternative. Often all but one alternative would have been eliminated before performing a detailed assessment.

2) The provision of decision aid to decision makers at higher level or other actors inside the same category (e.g. analysts to designers of flight control or department of aviation control). In this category, the analyst receives an assignment from a manager with higher authority. The task is to recommend the best possible solution to a problem. This is a setting typical of more strategic decision analysis. The executive has defined the problem. The process of identifying alternatives, analyzing them with respect to their consequences and risk, evaluating them and recommending a choice on this basis resembles the classical structure of decision analysis. The task of analysis should be a) with more or less involvement from the decision maker, define relative affected objectives expect the wildlife

Hazards' control or management; b) establish a set of alternatives decisions or option to be assessed; c) with assistance from databases and experts, for each decision alternative collect data and information to be used; d) establish some form of model (fault tree, cause-consequence tree etc.) relating knowledge at a lower level to expressions of consequences and risk at higher level.

3) Risk analysis and pre-programming of decisions rules for sharp – end functions. In this category, the involved personnel tend to apply pre-programmed skills and rules in dealing with system feedback and problems. This implies that a set of contingent decision rules to deal with possible system states needs to be developed. This can be achieved after a prior risk analysis. On the basis of undesirable outcomes, one needs to assess which observations could produce these outcomes. This can be done by using fault tree analysis for example. In addition to the specifications of rules, the product of these exercises should be the documentation of the assumptions of used in the analysis and the criteria used in determining the rule set. An important element of the blunt –end pre-programming, then, is the continued experience feedback and updating of knowledge, risk and uncertainty and, accordingly, the rules. Experience can then be compared to the predicted consequences and the risk statements.

### *3.1.5 Crises and emergency management in bird strikes*

Crisis and emergency are given many meanings in management terminology, ranging from a situation which is not manageable inside normal planning and

processing routines, via presence of serious threats that require prompt action to extremely dynamic situations with major consequences such as a hull loss air accident (ISO, 2002). These situations have in common that they relate to an environment evolving dynamically with serious but uncertain consequences (Samurcay & Pogalski, 1991).

Decision making is mainly concerned with limiting negative consequences. During crises different patterns are observed and are required. The rate of information is often high, the time constraints are narrow, the options may not be obvious and the consequences of an action will be uncertain. Decision – makers, who normally perform in a blunt end manner, perform under extreme hazard exposure. A decision – maker faced with a crisis needs not only to find a way to avoid adverse outcomes but he also needs to limit anxiety and stress to a level that is tolerable and compatible with efficient coping. Unaided, the like hood of inadequate decisions is high (Klein & Grandall, 1995).

Appropriate behavior in emergency and crisis settings obviously depends on contingency planning and emergency training. Because we are dealing with situations for which there usually exists little or no direct experience and which develop highly dynamically, this type of planning requires prior risk analysis. The purpose of the risk analysis in these cases is not to support a specific decision, because the problem is not current or known in detail. The objective is rather to identify generic decisions and tie them to certain classes of situation. An example could be a procedure to perform an emergency landing of a helicopter in the event of sudden, heavy vibrations due to a serious bird strike on its propel axis. No specific casual analysis is used to support such a decision; no specific analysis of the direct effect of the vibration supports this decision. The procedure is deduced from the knowledge that a number of critical failures could produce heavy vibration, with no idea about the real cause, and an effective decision to mitigate the risk is to perform an emergency landing. Crisis management cannot be strongly linked to a specific level of authority. In a crisis the roles and authority of an individual can change. Depending on the severity of the crisis, functions at practically all levels of authority can become involved in decision making but first of all the pilots who face straightforward the crisis. (Transportation Safety Board of Canada, 1994).

Emergency is associated with high consequence contingencies and low probabilities. One could consider them a form of residue of the risk assessment. Because they are not dealt with in the normal decision-making and management processes, they require a different approach. The purpose of risk analysis and decision analysis in the case of crisis and emergency management is a) to identify critical situations to a degree of possible e.g. the occurrence of an

unusual bird migration stream next to airport, b) to devise generic strategies as a planning basis, c) to predetermine roles and responsibilities in the case of emergency and d) to allocate resources for emergencies. Planners and analysts should convince the airport manager to provide them with a plan for an immediately available course of action worked under calmer circumstances. This is similar to pre-programming of rules in support of operator environments. Professional bird strikes analysts should have a role in crisis situations as providers of real-time analysis, to offload the airport managers' need for information processing. Such work sharing is advocated even if analysis would have to be quick and "dirty".

### 3.2 Interactions between levels of authority participating to bird strikes' risk management

It's obvious that risk management in bird strikes requires close interactions among classes of decision settings. Sometimes these can overlap with specific organizational functions but they are not always identified as such. For example, a senior manager such as airport manager can be seen in a strategic management function, but under certain circumstances he can also perform as a crisis manager. The two cases would represent radically different constraints and, accordingly, the mode of decision – making would be expected to vary. Constraints of many settings in which decisions affecting risk are taken do not allow for normal analysis. Figure 3 sketches a framework for the different roles, responsibilities and relations.

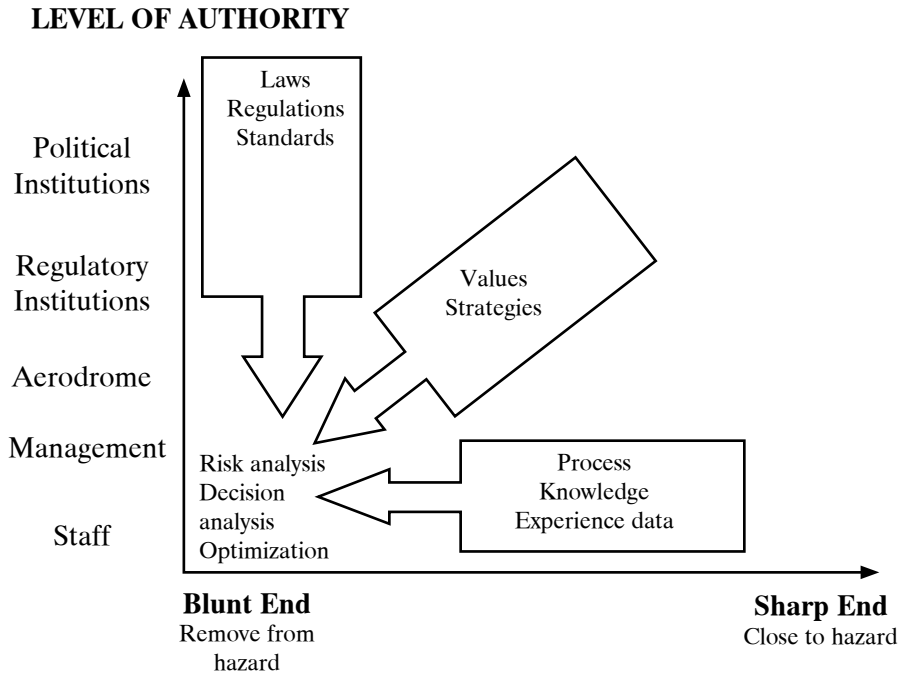


**Figure 3:** Influences from high authority and sharp end decision settings on bird strikes analytical processes

Higher authority and sharp end actors provide a knowledge base and a frame of legal, social, environmental and economic values. Political institutions and standardization agencies process public norms and values through different forms of discourse and decisions on laws, regulation or standards. These form part of the background and influence organizational assessment of risk. Executive management positions of Civil Aviation Authority (e.g. airport operator, manager etc.) express values and strategic priorities through strategy documents, guidelines and a variety of formal and informal instructions and messages. These form references for analysis and evaluations by analytical functions. Operational environments (e.g. wildlife managers, control tower personnel, wildlife patrol team, pilots etc.) provide updated process knowledge and experience data, which serve as input to analytical processes through reporting systems, database records and informal communication. The analytical function processes these inputs and information through model building, drawing inferences about prediction and risk and some form of optimization. The product or output of the analytical function is largely support and pre-programming of decisions for decisions settings that do not favor formal analysis. These principles are stylized in Figure 4. For the political setting and managerial setting, the

output would consist of predicted consequences and risk and in some cases it would include recommendations for decision.

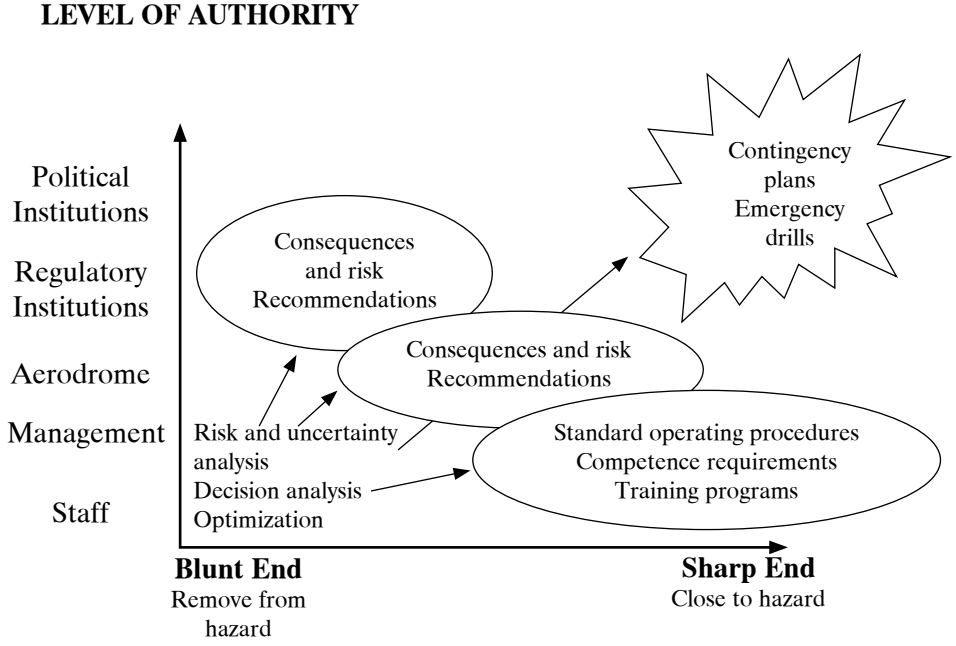


**Figure 4:** Analytical support of high authority and sharp end decision settings

For operational environments the analysis would provide skill or competence requirements and standard operating procedures (e.g. operational manuals, maintenance manuals, troubleshooting manuals). Contingency planning requirements should be identified for all settings, including emergency procedures, contingency measures and resources and requirements for emergency practices. In order to have an impact risk analysis need to understand the constraints facing decision – makers in other settings and the strategies used by decision – makers to cope with these constraints (Rosness & Hovden, 2001).

## 4. Conclusions

From discussions here it seems apparent that risk and uncertainties in bird strikes prevention especially, are dealt with managed, through interaction and communication among a large number of actors with totally different roles. The main problem is happened when an analyst intended to solve a bird strike problem, does not take into account the total ecological, social and economic environment, under the framework of sustainable development which affect

or cause bird hazards, through a holistic analytical risk assessment where are examined all classifying sources of risk (physical, social, political, legal, operational, economic and cognitive environment) (O' Connell, 1976). In other words when does not take into account the legal framework, the international and national operational rules, the land use planning (if there is) next to airport, the developing, existing and future, trends of the area, the knowledge and the point of view of stakeholders about the problem, even though the management of case study area at the past.

Of course since sometimes there aren't precise land use planning adjacent to airports or environmental impact assessment for the majority of man made activities next to airports, seems to be created risk chains which lead to non reversible events for flight safety.

Therefore in many airports the majority of attempts of mitigating bird strikes are happened after a major accident since there isn't that framework for negotiations and formal debates beforehand, which allow the participated bodies to agree with a common, accepted strategy.

In parallel, the divergent legal mandates and different missions in association with intergovernmental conflicts (or among different levels of government) among government agencies that administer programs related to the area off an airport due to differences in agency outlook and type, differences in external constituency groups and lack of information or communication, which affect with one way or another the bird strike risk, make the effort of mitigation of risk sometimes ineffective, in terms of controlling the conflict between flight safety of an airport and the incompatible land uses around of it. However, an effective decision making depends on the good level of understanding of the area and the implementation of effective ruling - administrative such as zoning, by acts etc., tools as well as economic and social tools such as user and product charges, tax differentiation, soft loans, non compliance fees, incentives for source allocation etc. and erosion of public awareness respectively (Lykos, 2005).

In terms of aerodromes which lain adjacent to National Parks or wildlife refuges is recommended the establishment of a decentralized, managing – coordinating body of the whole area with planning, regulatory, negotiate and representative role among all the participated bodies.

This is also recommended in the national level, since the operational, financial and political links among different levels of government also requires consideration and coordination to the direction of bird strike mitigation, it's obviously clear that, for the formal interactions and processing of risk, we require a common understanding, practice and terminology.

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