***Risk and Integrated Water Management***

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# *Risk and Integrated Water Management*

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## *Abstract*

Managing risks has long played a role in the development of the water sector. Such risks can be divided into two broad groups: resource groups that include natural or human induced hazards which water managers seek to regulate, and the enterprise risks faced by any water management enterprise in the execution of its functions.

Although risk management must be based on good physical science and technology, they alone cannot be the main basis for decision making. A more holistic approach, embracing the Dublin principles, is needed. It is evident that water related risks are currently handled by sectoral and highly segmented management systems which leads to major inefficiencies and inequities in the allocation of risk, risk mitigation costs, and security benefits.

There is a need to recognise that risk is not a physical phenomenon but a cultural one and that risk mitigation is an economic and social good. Risk management is a distributive issue, involving complex trade-offs and the re-allocation of real welfare between different economic, social and interest groups.

Designing institutions capable of taking a more holistic and public preference based approach to water related risks will never be easy and certainly there is no design recipe that is readily available and applicable for use everywhere. However, one potentially useful approach is to consider what risk management tools, strategies and organisational arrangements would be most appropriate from an economic efficiency perspective. From such a perspective governments would want to employ the least intrusive, costly and extensive means of risk regulation that is possible in each case. Study of the economic characteristics of hazards and related risks can help identify areas where individuals, communities or stakeholder groups are best placed to make risk-safety trade-off decisions and can inform decisions about the appropriate spatial scale of regulatory organisations.

It is not claimed that economic efficiency should be the sole basis for risk management decision making. However, it is argued that the conventional approach to institutional design based on the physical nature of the hazard and the technological means of regulating that hazard is not sustainable, effective or welfare maximising.  There is a need for a new approach based on a clear understanding of the economic characteristics of the risks, or public preferences and of societies' willingness and capacity to adopt different risk management strategies.

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## 1. RISK AND WATER MANAGEMENT

Managing risk and uncertainty has for long played a key role in the development of the water sector. This has inevitably been so given that water is a temporally and spatially variable resource, subject to extreme events. It is now well known that ancient societies had developed quite sophisticated water harvesting and management systems to cope with the risks from supply irregularities and to allow crop production in semi – arid areas (Clarke 1993). Likewise, there are very early examples of societies responding to flood hazards by developing control systems; one well documented case being the Min River scheme in China, which was developed in 250 BC to control floods and provide irrigation water, and is still in operation today (McDonald and Kay 1988).

Inevitably over time with population increases and greater demand pressures on the resource base, the range and scale of water related hazards has changed. The way that professionals and the public have perceived the risks associated with these hazards and have responded to them has been a critical influence on the development of conventional water management systems. For example, the perceived need to develop supplies to meet all the "requirements" of different user segments, thus reducing the risks associated with shortage, has played a critical role in shaping provision practices, investment patterns, administrative arrangements and indeed the entire techno structures of water management agencies. Likewise, the public health risks created not by a natural hazard but by human produced pollution was a vital factor in the nineteenth century "municipalisation" of supply. The attitudes towards urban provision engendered at that time remain with us today; water provision is still often regarded as a public health and welfare service rather than as an enterprise producing an economic good.

During the second half of the twentieth century it became increasingly evident that the traditional technology based and sectoral approaches to water management were failing to keep pace with the demands being placed on the resource. Millions of people today remain at risk from the lack of clean water; public health risks from inadequate sanitation affect some 50% of the world's population, and the number of people at risk from floods and drought continues to rise. At the same time risks from degraded ecosystems have increased inexorably; wetlands have been destroyed, over abstraction has lowered water tables and caused major rivers to cease flowing to the sea, and both ground and surface waters have been grossly polluted. There is now widespread agreement that we already face "a chronic, pernicious crisis in the worlds' water resources" (Cosgrove and Rijsberman, 2000 p. 11); a crisis, which puts at risk "the water system that we depend on for our survival" (World Water Commission 2000 p11).

According to the World Water Commission bad management practices lie at the heart of the water resource problem and similar views were also expressed in the Global Water Partnership's (GWP) "Framework for Action" (2000). "The water crisis is mainly a crisis of governance. The present threat to water security lies in the failure of societies to respond to the challenge of reconciling the various needs for and uses of water" (p23). Both the Commission and GWP argue that currently unsustainable management practises must be replaced by a holistic approach based on the concept of integrated water resource management (IWRM). IWRM is seen as the means of providing water security, of creating sustainable water policies and practices and of averting the risks to the global water system. In other words IWRM is ultimately about risk management, about avoiding water system failure.

Risk is also, in a less all embracing sense, critical to the implementation of IWRM since virtually every element in water management involves decisions about levels of risk bearing or risk mitigation and about who will bear the costs or enjoy the benefits involved. Judgements about risk are clearly made, implicitly or explicitly, when managers seek to address particular natural or human induced, water related hazards (supply impurity, supply inadequacy, dam failure, pollution, extreme climatic events, ecosystem change or damage). Decisions about which hazards to address, when and where, by what methods and to what probabilities of safety or security obviously have distributional consequences. Inevitably, given limited investment funds and human capacity constraints, there are opportunity costs involved and trade-offs will have to be made. Improvements to supply security or drinking water quality for existing water consumers, may well, for example, leave the unserved exposed to the risks from water shortages and water-borne diseases.

Perhaps somewhat less obviously, risk and its allocation is critically affected by a wider range of policy decisions and operating practices which are not directly designed to address water related hazards. This wider range includes water right allocations, budgeting and charging systems and the design of water authorities or regulatory agencies. For instance, it is clear that charging systems can reduce or increase the risks of supply shortage or pollution damage depending on the way they affect the demand for water or wastewater discharge services. Likewise, the jurisdictional characteristics (functional and spatial) of water or environmental agencies will affect the range of hazard mitigation methods which can be applied, the capacity of the agency to address the problems and the population over which the mitigation costs can be distributed. It goes without saying that institutional design will also play a key role in allocating the range of "commercial" risks (design and construction, revenue and financial, and force majeure risks such as strikes or riots) to which all water businesses (public or private) are subject.

Given the importance of IWRM to a sustainable water future and the criticality of risk in most aspects of water management, it is perhaps surprising that there is relatively little in the IWRM literature which considers risk holistically. In 2000 the then Technical Advisory Committee of GWP noted in its paper on IWRM that "relatively little attention has been paid to the systematic assessment of risk mitigation costs and benefits across the water use sectors and to the consequent evaluation of various risk trade-off options" (p. 11). However, the paper did not subsequently address risk and it's allocation, apart from a brief mention of risk assessment tools.

This current paper attempts to address this neglect. It first considers the categories of risk faced by water managers and water users and the meaning of risk. This is followed by discussion of the relevance of the Dublin Principles to water risk decision making. It will then consider the different risk decision principles that can be used to address water-related risks and goes on to evaluate the design of institutions for risk mitigation and allocation. Finally, by the way of a conclusion it will be argued that risk management is a distributive issue that cannot be treated solely as a technical matter best handled by experts. It involves the allocation of wealth and welfare between water sectors, communities and individual users; those affected need to be involved in decision making.

## Risk Categories

As has already been argued IWRM is essentially about risk management in the very broadest sense, since it seeks to change those water management practices (or malpractices), which currently endanger the sustainable development of the resource and the welfare of societies which depend upon it. However, for practical purposes it is necessary to take a less all-embracing view of risk and be more specific about the different types of risk which are faced in the sector. These can be divided into two broad groups, resource and enterprise risks (figure 1). The former include those natural or human induced hazards, which water managers seek to regulate, while the latter are the risks faced by all water management enterprises in the execution of their functions.

### Figure 1: Risk Categories

| *Resource Risks* | *Enterprise Risks* |
|---|---|
| Supply security | Design and construction |
| Raw water quality/Safety | Operating failures |
| Extreme (non-average) climatic events | Market risks |
| Public health | Financing risks and shortages |
| Environmental, including water pollution | |
| | Political and legal risks |
| | Labour risks |
| | Compliance risks |
| | Contingent liabilities |

Although these two broad categories are conceptually distinct, in practice they are intimately related. First, the capacity of water management agencies to tackle resource risks will be critically affected by the way enterprise risks, such as financial uncertainty, are handled. Second, enterprises may themselves be subject to resource risks; most obviously a water supply utility may fail to provide the specified quantity and quality of service if its raw water allocation is insecure or if intake quality cannot be assured. Third, the manner in which resource risks are managed may affect enterprise risks. For example, failure to provide acceptable supply security may increase market risk and financial uncertainty if customers refuse to pay for the inadequate service (rate strikes) and may well increase political risks. When designing risk management strategies, institutions and practices it is necessary to recognise the interdependencies between resource and enterprise risks. However, in this paper attention will be focussed on resource risks.

Until relatively recently there was little open discussion about many of these risk categories. Decisions about a whole range of safety or security standards were made by sectoral managers employing professional norms with minimal transparency or public involvement in the choice process. In Britain, for example, it was the professional norm to attempt to develop sufficient reservoir capacity to meet the one in fifty year drought event but the economic and social justification for such a norm is at best obscure. Other decisions about risk allocation were in effect made by default as a product of the political bargaining processes which determined the budgets of different sectoral water management agencies. As water management was, and still is, largely a public sector activity it was rare for enterprise risks to be openly acknowledged, although they clearly existed. Not surprisingly, there has been little public understanding of the risk trade-offs being made on their behalf and there are still few mechanisms through which citizens can express their risk mitigation preferences.

## 2. Risk: A Scientific and Social Concept

The neglect of public input into risk mitigation and allocation decisions arises in major part from the way water professionals have typically defined risk. Although there are sub-sectoral differences in the approach taken to different types of water-related hazard and the associated risks, it is true to say that conventionally all the sub-sectors have shared the view that risk is a technical matter, amenable to quantification and controllable by some form of structural intervention. Water managers, like other hazard managers, have relied heavily on the bedrock of science and probability, employing detailed knowledge of past events to model the future. They have, thus, attempted to reduce the uncertainty inherent in the notion of risk.

Typically risk has been reduced to a single equation, which links quantitatively the probability and magnitude of a hazard event with the costs of the consequences (expressed in monetary terms) if the event actually occurred. According to Rosa (1998 p20) such equations have made it possible to convert risk into a common, supposedly, objective, set of figures upon which "rational" management decisions could be based. Certainly in the process risk becomes depersonalised; "persons or material exposed to a hazard are called the elements at risk" (Tseng *et al* 1993) and people vanish into the hazards – consequences equation. Importantly in the water sector the costs likely to be incurred by a hazard event have conventionally been compared with the costs of changing the probability of that event through structural interventions (larger reservoir and bulk transport systems, higher flood defences, more advanced water and waste water treatment plants). With the exception of the flood control sub-sector, relatively little attention has been paid to reducing the consequences arising from natural events by altering the vulnerability of the potentially affected populations. Likewise for anthropogenic hazards, such as pollution, the set of potential "solutions" has frequently been restricted, with much more attention paid to clean up technologies than to tackling the causes of the hazard at source.

Although risk management of necessity needs to be based on good physical science and technology, it is increasingly clear that they cannot be the only or indeed the main basis for risk management in the water sector. There are four basic reasons why this is the case. First, and perhaps most crucially, risk is not a physical phenomenon but a cultural one, conceived of as the dangers that societies define as troublesome. As Jaeger *et al* (2001) argue "risk, in human terms, exists only when humans have a *stake in outcomes* (p.17). We cannot and do not live in a risk free society; indeed the taking of risks has been the engine of economic and social development. Social, political and cultural processes determine whether particular conditions are unacceptably risky and, therefore, justify the introduction of risk reduction measures. Moreover given that risk reduction is never a costless activity, socio-economic and political factors must come into play in establishing spending priorities.

Second, and now very well established, is the fact that physical events do not in themselves create the risk of harm; it is often human activity (e.g. moving into flood plains and coastal zones, growing water hungry crops in drought prone areas etc), which generates the risk. Moreover, many of today's water-related risks (from pollution, ecosystem degradation, urban flash flooding and so forth) are directly human induced. Any solutions to such problems which focus on managing the water and fail to see that the causes lie in the way societies manage their economies will inevitably only act as a temporary band-aid.

Third, it has for long been pointed out that when planning for water development and use, physical/hydrological uncertainty is often not the only, or indeed the most important source of uncertainty. Although discussions of risk in water planning have traditionally been dominated by uncertainty in hydrology (and even more so today with concerns over global warming), this to quote Peter Rogers (1999), “is, however, a little like the drunk looking under the lamp post for his lost keys because that is where the light is” (p. 4). As long ago as 1969, James, Bower and Matalas found that of four major sources of uncertainty facing Potomac River Basin planners economic, political and ecological sources were far more important than hydrological uncertainties.

Fourth and lastly, the water managers reliance on science and it's partner technology may in fact have increased risk. Indeed, those that characterise modern society as *risk society* have argued that the use of scientific technologies has led to large – scale technological and environmental risks (Beck 1992). At a less all embracing scale, in the hazard's case vulnerability to risk can be increased because technology can rarely control the hazard entirely although it can, of course, change the probability of event occurrence. By reducing losses from higher frequency, lower magnitude events the result could be greater risk of disastrous consequences when more extreme events occur. In addition, human responses to the perceived security engendered by hazard defence measures may not only increase vulnerability but also shift the costs of risk mitigation from the individual risk taker or risk producer to society in general. This is most evident and best documented in the case of flood protection, which has tended to increase occupancy of hazardous flood plains and coastal zones and has generated demands for still greater protection and compensation when failures have occurred. Non-technological solutions, which tackle the vulnerability to hazard events or for human induced hazards, which address the causes of the hazard, importantly do not serve to exacerbate long term risk.

For all these reasons risk assessments in the water sector have to go far beyond the scientific “objective” evaluation of natural and human induced hazards and human exposure to those hazards. It has to involve much better understanding of social, economic and political systems as risk generators, of the social-psychological processes affecting human responses to environmental conditions and of the way different risk management strategies affect the distribution of hazards and benefits throughout society. Science can clearly help us understand that a hazard exists but it cannot automatically be assumed that social systems either *can* or *should* attempt to reduce the dangers. Likewise science and technology may provide information on some risk mitigation strategies but cannot determine which strategy is economically, socially or politically acceptable.

## 3. Resource Risks and the Dublin Principles

The Dublin principles, which have underpinned much IWRM thinking, have clear relevance to attempts to improve the way risk is handled within the sector.

### Holistic Management

It is evident that water related risks are not managed holistically; indeed in most, if not all countries, there are few institutional arrangements in place which would make this a possibility. Sectoral and highly segmented management systems create major inefficiencies and inequities in the allocation of risk, risk mitigation costs and increased security benefits. Although there are many reasons why lack of holistic management fails to ensure that risk decisions are made to meet welfare maximization, social justice or environmental sustainability criteria, three appear most important.

First, land and water managers (at all levels from national agencies to individuals) are able to engage in *risk* and *cost shifting* rather than genuine risk reduction. Risk shifting comes in many guises. It can obviously take place within a river basin when, for example, upstream water abstractors reduce their own water security risks by taking a disproportionate share of available resources and leaving downstream abstractors exposed to greater scarcity risks. Given the nature of water as a hydrologically interconnected, multi-purpose resource such upstream water security decisions often generate different forms of risk for downstream populations by increasing the potential harms from inadequately diluted pollution or by endangering downstream ecosystems. In other cases water or land managers are able to make economic decisions without considering the potential harms (the externality costs) imposed on others. This obviously occurs when inadequate expenditure on wastewater treatment results in the export of pollution risk to all downstream water users, including flora and fauna, which depend upon the quality of water flows. Other examples, include land use decisions (deforestation or urban development) which magnify downstream flood risks or decisions about risk mitigation technologies which simply transfer risks to others. Coastal and flood plain communities have, for instance, been able to improve their own defences and in effect have simply shifted the risk to undefended areas. Indeed it has long been argued that urban drainage schemes based on hard technologies have not only shifted the risk but have considerably magnified it by concentrating and speeding up flood flows.

In addition to spatial risk or cost shifting, it is also important to note that risk can and has been shifted over time. The mining of groundwater today will clearly affect the water security of future generations; inadequate irrigation and drainage schemes which result in salinization may impinge upon future food security; while ecosystem damage now may critically reduce ecosystem services in the future.

Inevitably all these unplanned and largely unevaluated reallocations of risk and costs cannot meet the IWRM objective of maximising economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

The second reason why the currently segmented water management systems produce inefficiencies and inequities in risk allocation stems from the opportunity cost issue eluded to earlier. In most countries the financial and human capital available for investment in the water sector is highly limited and it is vital that attempts are made to ensure that it is spent in the most socially beneficial ways. Although water engineers and hydrologists have developed analytical techniques which consider complex risk and risk trade offs, these have for the most part been based on specific investment projects or a series of projects within one sector. For example, Rogers 1999, discussed the decision tree approach for a flood control example, which takes into account economic, political and ecological risk parameters. However, while partially addressing risk tradeoffs such approaches do not confront the basic opportunity cost problem. The key question is where do our priorities lie; is it better in social welfare terms to invest in reducing flood, public health, water security, food security or ecological risks? There are economic appraisal techniques and participatory mechanisms which can be employed to address this question but they will only be used if the institutions exist to allow cross-sectoral choices to be made. It would be naive to expect any system to produce "perfect welfare maximization" decisions but not to hope that more intersectoral co-ordination will improve risk trade off choices. Of course, these trade-off issues go far beyond the water sector; if, for example, the key objective of public policy is to improve health it is legitimate to ask whether investments in water treatment or the removal of lead pipes should occur at the expense of AIDs education, cancer treatment or the reduction of heart disease.

The third major source of inefficiency inherent in segmented management lies in perceptions about the most appropriate strategies for coping with risk. It is now widely accepted that there is a whole range of potential strategies ranging from hard engineering "solutions", through vulnerability reduction measures, to loss pooling and loss bearing. However, it is still rare for the full set of options to be evaluated and the most cost-effective or most welfare beneficial strategy to be adopted. The perceived option set is critically affected by the jurisdictional boundaries (in both spatial and functional terms) of the relevant management agencies and by the professional training of the staff. The incomplete option problem has been very well documented for over fifty years in the flood risk case (White 1942, Kates 1962) and although in some countries a wider range of potential adjustments to flood events is now considered, the bias towards structural adjustments is still commonplace. Holding dams, protective embankments, removal of natural flow obstructions, channel straightening and canalisation are still likely to be perceived as the most appropriate measures in preference to non engineering methods of flow regulation (catchment land use management), vulnerability reduction measures (land zoning, changing flood plain cropping patterns, building design) or loss pooling schemes (insurance). In other risk sectors it seems to be the case that even less progress has been made in exploring the full strategy option set.

### Participatory Approaches

The second and third Dublin principles both emphasis the need for stakeholder participation in water development and management. If risk is a cultural not a physical phenomenon and if risks are created anthropogenically it follows that stakeholder participation must play a critical role in risk management. Only with such participation can we address key questions, such as:

a) which levels of expenditure on risk mitigation can be justified in user preference terms,
b) under capital and human capacity constraints which risks are the least acceptable and thus the priorities for action,
c) who will bear the remaining risk costs and to whom should the costs and benefits of risk mitigation be allocated,
d) which risk mitigation methods are most acceptable in economic, social and political terms,
e) how will the affected public respond to different risk reduction measures,
f) how far can risk mitigation be regarded as a private rather than a public good, and thus subject to private choices,
g) which risk reduction measures does the community have the will or capacity to introduce and maintain.

Additionally it should be noted that failure to involve the affected publics in risk assessment and the development of risk mitigation strategies can result in inappropriate actions because valuable local knowledge is ignored by remotely located risk experts (Wynne 1991).

It is, however, easier to say that stakeholder preferences must play a role in establishing risk mitigation priorities and practices and in distributing the costs and benefits throughout society than it is to achieve this in practice within the water sector. The fact that we are dealing with a multi-purpose, common property resource which exists in interconnected hydrological systems can not only make it difficult to identify all the stakeholders but it is inevitable that stakeholders will have different preferences, priorities and economic interests. Moreover, preferences and values will not be constant over time but will vary with experience of the hazard, the availability of information about potential risks, with the benefits that others are perceived to have received from risk mitigation investments and with a range of cultural, social, economic and political circumstances.

In addition, there is now a large literature that shows that when faced with risky decisions, people are vulnerable to various kinds of biases and inconsistencies. This has led some analysts to argue that many risk decisions are too important to be left to the public with their irrational, confused views based on imperfect knowledge and a poor understanding of probability; policies should from this perspective be based on only the most informed opinions. On the other hand others have pointed out that expert rationality based on science and probability is only one form of rationality, personal preferences which diverge from the expert view are not necessarily irrational (see for example Slovic 1992).

In the past expert opinion has dominated risk management decision making in the sector and there are undoubtedly risk domains where this dominance may need to continue, for example if individual preferences will result in the spread of risks (disease) to others or if preference bias towards current economic advantage will exacerbate future risks. It is not then a question of giving stakeholders total responsibility for all risk decision making but of ensuring that they are given a due role, and that perceptual preferences are considered alongside expert analysis. This is important as it cannot be assumed that water risk experts are neutral, disinterested protectors of the public good. Self-evidently they are not; at the crudest level maintaining jobs, budgets or research grants and the aggrandisement of bureaucracies will all influence decision-making. Indeed Jasonoff (1982) and others have argued that a scientifically expert elite is neither qualified nor politically legitimated to impose risks and risk management policies on the general public.

### Risk Mitigation As An Economic Good

"Many past failures in water resources management are attributable to the fact that water has been – and is still – viewed as a free good" (GWP. TAC 2000 p. 18). This applies with just as much force to risk management, where it has been relatively rare to view risk mitigation as an economic good which can be subject to market discipline. There is no doubt that the demand to "consume" safety will outstrip the capacity of the sector to deliver it unless mechanisms exist to make consumers aware of the provision costs involved.

However, while it is easy to identify free safety provision as a problem, employing market forces to determine the appropriate level of safety provision and the distribution of hazards and risk mitigation costs is itself problematic, not the least because lack of markets and market failures are so prevalent within the water sector.

Governments would need to create markets and "correct" failures before market mechanisms will produce an optimal allocation of risk and safety and optimal investments in increasing supplies of safety. In practice there will be many cases within the water sector where the costs involved in attempting to correct the market failures will far exceed the benefits involved.

While market failure problems will undoubtedly place limitations on the use of conventional market tools, such as pricing or permit trading, in the allocation of many water related risks, this does not mean that economic good concepts have no practical relevance. The distinction made by GWP TAC (2000) between *value* and *charging* is relevant here

(p. 19). We may not be able to charge individuals for all the risk mitigation expenditure made on their behalf or for the risk costs they impose on others. However, we can attempt to place an economic, social and environmental value on different risk management options to provide the information on which water and land managers, communities and individuals can base their decisions. In addition thinking about water risks in an economic context has important implications for the design of risk management institutions; implications which will be explored in a subsequent section of this paper.

## 4. Risk Decision Principles

As was said earlier given the sub-sectoral approach taken to water management it is hardly surprising that there are major differences of approach taken to the different types of water hazards and the associated risks. This is not necessarily a bad thing if such differences reflect genuine variations in public preferences or in socio-economic conditions. However, given the dearth of material in the water literature which seeks to describe and explain such variations, there must be a considerable suspicion that the different risk management practices and the decision principles employed have more to do with historic accident than with informed design.

There are observable variations in the risk tolerance levels deemed to be acceptable for different types of risk. Why, for example, in Europe are precautionary principles adopted for drinking water quality which in effect imply zero risk tolerance levels, while public health risks from sewer flooding, or the recreational use of polluted water are not regulated with such stringency? Likewise, notable variations occur in the criteria employed to “charge” different types of risk generator for the costs they impose on others. Why, for example, is the polluter pay principle accepted in theory (if not adopted in practice), while there is little or no discussion of charging those who exacerbate flood hazards by changing land uses? Similarly, why are some risks regulated nationally or even supra-nationally, whereas others are left to local governments or individual choices?

Generalising broadly there are five competing sets of decision principles, which are relevant for water related hazards and risks (figure 2). First, precautionary approaches can be taken or managers can react to risks as they occur and as public pressure mounts for action (the so called tombstone approach). Second, safety standards can be uniformly applied over whole countries or subsidiarity principles can be adopted. Third, individuals can be left to make their own risk taking or mitigation decisions or the government at various levels can practice "maternalism". Fourth, risk tolerance or safety standard levels can be determined by professional experts or left to some form of political bargaining process, which can either be closed to the public or genuinely participatory, involving all stakeholders. And finally, some principle of cost allocation needs to be decided; should risk generators pay, or risk bearers pay or the government pay from general or local taxation.

Figure 2: Decision Principles

| | | |
|---|---|---|
| Precautionary | v | Reactive |
| Uniform | v | Subsidiarity |
| Individual choices (markets) | v | Maternalism |
| Professionally determined Methods/Standards<br>– Historic standards<br>– QRA<br>– CBA/cost effectiveness | v | Political Bargaining<br>– Untransparent closed<br>– Participatory, stakeholder involvement |
| Risk Generators Pay | v | Risk Bearer Pay v Government (Taxpayers) Pay |

The lack of a holistic approach to risk and the prevalence of major differences in the principles employed in risk management decision-making goes well beyond the water sector. Many authors have noted that even within one country striking variations exist across risk policy domains (variations in risk tolerance, extent and harshness of regulation for instance) (Hood *et al* 1999, Health and Safety Executive 1996). The reasons for such variations are widely debated but still poorly understood; one thing, however, is certain, the differences cannot be explained by any "objective" evaluation of the probability of harm or its scale. (Breyer 1993). In Britain, for instance, regulation of the radiation producers is much harsher than regulation of cigarette smoking, despite the fact that the probability of an individual dying in one year from smoking is 1 in 200, compared with 1 in 57,000 for radiation industry worker and 1 in 10,000,000 for members of the public potentially affected by the release of radiation from nuclear plant. Regulation of rail safety is much stricter than road safety although the risks of death are much less (1 in 500,000 compared with 1 in 8,000). Likewise, no one seriously suggests protecting the public from football although annual deaths on the playing field greatly exceed the risk of dying in a flood.

Some variations in approach may well be justified if governments have responded to the public who "dread" some forms of potential harm much more than others. Still other variations may be economically and socially rational if the costs of regulating the hazard exceed the benefits or if regulating one hazard simply creates other potential risks. It would be less easy to justify risk management variations if they arose simply from lack of any meaningful, systematic analysis or because particular stakeholders (including professionals) have had the power to impose their own risk preferences on others or to gain risk mitigation or risk shifting benefits at the expense of others. This would appear to be the case in the water sector. There has been little cross-sectoral debate about appropriate decision principles for different forms of risk and yet the adoption of the various principles has critical implications for the costs of risk mitigation and its distribution.

## 5. Institutional Design Decisions

Designing institutions capable of taking a more holistic and public preference based approach to water related risks will never be easy and certainly there is no design recipe that is readily available and applicable for use everywhere. Generalising broadly the key design decisions can be grouped under four main headings:

a) *The level of governmental involvement;* which hazards should be regulated by governments at various scales and with what degree of strictness?
b) *What policy strategies and instruments should be employed?* This not only involves decisions about laws or economic incentives but also about appropriate risk reduction or risk bearing strategies (changing event probability or vulnerability, loss bearing or loss sharing).
c) *What organisations should be in place?* Organisations would include stakeholder fora, co-ordination and co-operative mechanisms as well as agencies with a direct risk mitigation role, either as safety providers or as regulators of the actions of others. In many cases these organisations would need to involve those outside the water sector or be capable of operating outside the sector.
d) *What risk assessment methods should be employed?* These assessment methods would not only include well-established quantitative risk assessment and cost-benefit analysis, but also participatory or psychometric methods to evaluate risk perceptions and risk-safety trade offs.

Although these four groups do represent distinct decisions, they are very closely interrelated. For example, if for some hazards it was judged possible for the national government to be purely an enabler, this has implications both for the appropriate policy instruments and organisations. Likewise the choice of a risk reduction strategy, such as employing structural interventions to reduce hazard events to a set frequency, clearly helps determine the type of organisation required for effective implementation. Attempting to employ a risk reduction strategy or a policy tool, such as command and control regulation or economic incentives, in an inappropriate organisational setting is a recipe for failure; organisations need to have not only the jurisdiction to implement strategies but also the necessary human capacity and financial resources.

## An Economic Approach to Risk Institutions

One potential starting point for the consideration of institutional design is to assume that economic efficiency (the maximization of total social welfare) is a legitimate and important objective of risk management in the water sector; this assumption is, of course, consistent with the definition of IWRM. It should be stressed that there is no suggestion here that efficiency is the *only* objective of risk management policy. Nor is it claimed that in the real world it will be possible to design institutions which conform “perfectly” to efficiency principles; rather such principles can be employed to inform choices about management tools, strategies and organisational arrangements. Given shortages of financial and human capital it is not unreasonable to suggest that governments should want to employ these scarce resources in ways which advance social welfare. Nor does it seem unreasonable to argue that there are risk areas where individuals, communities and stakeholder groups can be the best judges of their own welfare.

Whereas most water professionals are very familiar with the physical characteristics of a hazard (e.g. the hydrological regime, chemical composition and biodegradability of pollutants) and have employed these in developing risk management polices and tools, much less attention has been paid to the economic characteristics of hazards and any associated risks. An economic approach would naturally begin with these characteristics, considering first the question of why markets currently fail to produce an efficient allocation of risk and risk mitigation costs (the market failure approach) for each hazard.

There are seven key sources of market failure, which need to be considered:–

1. Non-existent markets, externalities and common property.
2. Public and merit goods or services *(services which are provided to benefit communities not specific individuals or which individuals should receive even if they are unwilling or unable to pay).*
3. Transaction cost problems *(where the cost of creating markets exceeds the benefits involved).*
4. Imperfect knowledge and information asymmetry *(those vulnerable to risks lack the knowledge to make informed choices about their own welfare).*

5. Product choice constraints *(cases where risk and safety cannot be bought separately).*
6. Monopolistic risk producers.
7. The unrepresented future risk taker.

Some of the causes of market failure are "natural" in the sense that they arise from the inherent properties of the hazard or the water service that could create harms. In other cases they occur because management and regulatory systems have failed to provide mechanisms for individuals to express their risk preferences. The distinction between "natural" and "management" failure can be demonstrated by an example. Typically there are no markets through which individual urban water users can express their demands for a particular quality of product or security of supply; they have to take what is made available by a monopoly supplier. In the quality case the market failure is natural; it is not feasible to provide different levels of quality security within a single supply system. However, technically it would be possible (all be it difficult and costly) to provide different levels of supply security, assuming metering, peak load pricing and peak cut off mechanisms. Tariff schemes under which industrial users pay a lower charge if they agree to supply cut-offs during short-term peak periods are not uncommon in the energy sector and a few such schemes have been reported for water. In the same way, it is possible to design tariffs for abstraction water which allow users to make their own security decisions; if abstractors can take water freely or at very low cost during winter but are charged highly for summer abstraction they clearly have the option of investing in their own security reservoirs.

Having identified the specific features of each hazard that is subject to market failure and the type of market failure, the next stage in the economic approach would be to explore the potential ways of correcting such failures. To be efficient governments would want to employ the least intrusive and extensive regulatory response that was possible in each case (the minimal feasible response model) and, in addition, would only attempt to correct these failures where the benefits exceeded the costs. In other words, from an economic efficiency perspective governments should, *wherever possible,* act as an enabler, tackling those failures which inhibit individual (or community) choice and providing mechanisms through which demands for safety/security can be articulated. Once again this is consistent with the envisaged role of government within an IWRM framework.

The words, wherever possible, are important because in the water sector there are undoubtedly risk areas where the minimal response, enabling role will be neither appropriate nor sufficient to address the hazard and related risks and there will undoubtedly be many cases where the costs of creating market like choice mechanisms (the transaction cost issue) will greatly outweigh any conceivable benefits.

### The Level of Governmental Involvement

In the real world historic precedence, public perceptions and political factors will have an important role in determining the appropriate level and type of government involvement in risk management. However, if national governments are seeking to use resources efficiently, are prepared to adopt subsidiarity principles (only addressing risks where local governments or communities could not address the problem) and are willing to take a demand driven approach, then analysis of the economic characteristics of particular risk can help inform decisions about the spatial scale and coerciveness of risk regulation. Five economic characteristics are of particular importance.

First, there is the question of *jointness of risk consumption.* This simply means the extent to which people are unavoidably and jointly affected by the risks associated with a particular hazard. Jointness of risk consumption is intimately related to the ease with which individuals or indeed communities can opt out of the risk by taking avoidance measures. It is important to note that being jointly affected by a potential hazard is not the same as jointly consuming risk. Clearly all flood plain dwellers are subject to the same potential hazard, but individuals may be able to reduce their vulnerability (i.e. opt out of some of the risk) by altering their land use or building dwellings on platforms or by purchasing insurance. Where the ease of opt out is low and/or the costs of opt out are high, the expectation is that governments would need to intervene in some direct way and not confine themselves to enabling a private risk market to work.

Thinking about jointness of risk consumption and ease of opt out immediately suggests that there cannot be the same risk regulatory regime for each hazard in every country and indeed variations of regime within one country may be appropriate. This arises because the ability of individuals to opt out of risks varies greatly. For example, whereas in a country like Britain opting out of flood risks is possible (all be it costly) by not moving into or migrating from hazard zones, such options would clearly not be feasible in Bangladesh or large tracts of Mozambique.

Ease of opt out can also vary with the severity of the hazard event; individuals and community groups have, for example, coping mechanisms to deal with relatively short term droughts or high frequency floods but these may not be adequate to deal with low frequency, high magnitude events.

Likewise, the range (and cost) of opt out measures varies markedly, not only with the nature, scale and frequency of the hazard event but also with the socio-economic and political conditions in a country. Flood or drought insurance, for instance, is simply unobtainable in many less developed countries and even in industrialised or industrialising countries may not be available (or be prohibitively expensive) if hazard events are very frequent or if the scale of the event means that a high proportion of the insured will claim at the same time. As Smith (1991) has pointed our there are many cases where commercial insurance companies have been made insolvent by large scale events and inevitably those remaining seek to limit their liability in various ways (p. 94).

In addition the capacity to opt out is income contingent. It is relatively cheap for those in Western economies to avoid possible harm from impurities in drinking water (pesticides, lead) by buying bottled water to cover the fraction of total consumption which needs to be of potable quality, this option is more restricted in very low income communities. Clearly the same ability to opt out problem exists in the insurance case.

It is perhaps worth noting at this point that it is immediately evident from the drinking water example, that, in the real world risk mitigation or regulatory regimes do not adhere to rational expectations. Massive expenditures have been made and are still being made to comply with the European Drinking Water Directives, which in essence have sought to apply a zero risk, precautionary principle. The costs involved have been recouped in whole or part from captive consumers irrespective of their willingness and ability to pay or of their willingness to take individual (and arguably cheaper) opt out opportunities. In Britain for example, customers have had to fully bear costs of some £2 billion to ensure that their supplies comply with pesticide regulations and it is estimated that lead removal with cost them a further £6–7 billion. This example acts as an important lesson since the standards were largely set by "expert" opinion with no significant assessment of the costs and benefits and with little meaningful involvement of the public in the choice process. The opportunity costs of this regulatory regime are large in any country and could be an impossible burden in countries where financial resources are critically scarce; Rolls Royce risk safety in one sector inevitably means that other potentially more highly valued goods and services have to be foregone.

The second relevant economic characteristic is the *geographical scale of joint risk consumption.* The scale issue has already been shown to affect ease of opt out. However, the spatial scale of jointness could also inform decisions about which tier of government (or community organisation) would be the most appropriate risk regulator or manager. The rational expectation is that national governments would adopt the subsidiarity principle for spatially confined issues. If, for example, a pollution risk was confined to one locality it would be possible for the government to enable the use of economic instruments or dialogue between the polluters and those bearing the risk, rather than employing national coercive quality standards on the discharges of all polluters in the country.

A third important characteristic is *excludability from risk mitigation benefits.* Enabling measures, which allow or encourage individuals, companies, local communities and lower tiers of government to make their own decisions about risk mitigation measures, are only likely to be effective if it is possible to exclude those unwilling or indeed unable to pay the costs involved (i.e. the free loader problem). In some cases it may be physically possible to exclude free loaders (deny access to a clean water source, refuse entry to a flood shelter; provide no loss bearing help to those without insurance) who have not contributed to the safety provision. However, this clearly has ethical and equity implications, particularly when ability to pay is a factor behind the failure to contribute. In practice where physical excludability is possible, governments will need to make judgements about whether the poor and feckless should be protected.

The fourth characteristic and in the water case arguably the most important for institutional design is the degree to which risks are subject to displacement (shifting) and spread. This has already been referred to in the context of the problems which arise from sectoral and segmented management systems. Risk displacement and spread involves four different elements:

a) *The extent to which losses made by some people will reduce the likelihood that others will suffer.* If this likelihood is high then it is possible for governments to take enabling actions to allow some form of market mechanism to be employed. For example, if upstream flooding (or other forms of water retention) can reduce the probability of flooding further down the river, there is the potential for those downstream to reduce their risks by buying protection from those upstream. This could involve paying for the maintenance of vegetative cover, for the provision of wetlands which can act as a "sponge" during wet weather or for land owners to provide flood washlands. Such a market system would be analogous to the scheme in Costa Rica whereby landowners would be paid to maintain or replace forest cover to increase effective water supplies.

(b) *The extent to which risk mitigation in area or time A will increase the probability of suffering in area or time B.* The more risk displacement the less likely that governments could allow private or community choices to operate in an unregulated way. In addition the scale of displacement will affect the spatial and jurisdictional extent of the appropriate regulatory agencies.

c) *The extent to which risk mitigation in one water subsector produces new forms of risk, including broader environmental risks.* This is a varient on b) above, but is an important one given the interdependencies which exist within the water sector and between this sector and other environmental media. For example, water permit or pollution trading schemes may be employed to reduce scarcity or pollution risks but they need to be regulated to avoid third party losses which are unconsidered by the private traders. Likewise, given the laws of thermodynamics which say that matter is neither created nor destroyed, it follows that the reduction of risks from water pollution should not be considered without evaluating the increased risks from air, ocean or land pollution. This again has implications for the design of regulatory agencies and also for the use of risk assessment tools.

d) *The extent to which losses for some people actually magnify the probability of losses for others.* The classic example here is the spread of disease; risk is in this case very much a public "bad" and one which the government would need to mitigate or regulate directly.

Finally, a fifth relevant characteristic is the ease and cost of gaining information not only about the hazard, it's probability and potentially harmful effects but also about the methods and costs of reducing vulnerability or of adopting loss sharing schemes. It goes without saying that individuals, communities or local governments cannot make informed decisions without information, but information collection is never costless. Access to information is one element which affects the ability of those at risk to make private or community "opt out" decisions. Where governments feel able to leave risk management decision making to others, it is often the case that the enabling role must include either the direct provision of information or command and control regulation which requires information to be provided. For example, in the United Kingdom it currently costs about £250 to have a single water sample tested and very regular sampling would be necessary if quality variability occurred. It would clearly be inappropriate to expect households or indeed small firms to bear such costs in order to assess the risks involved in using the supply.

## Ladders of intervention

With these five economic characteristics of risks in mind it is possible to conceive of *ladders* of intervention of three types (figure 3)

: the spatial scale of security provider or regulatory organisations (from transnational governmental bodies to the individual)

: the risk mitigation strategy (from hazard removal and hard structural interventions to loss bearing and loss sharing)
: the policy tools (from precautionary bans on hazard production or risk taking to the provision of enough information for individuals or communities to make their own choices).

Starting from the basic efficiency principle that governments should adopt the least intrusive and extensive response possible to an identified risk or sets of risks, then the search for acceptable solutions should start from the bottom rungs of the ladders. This does not mean that only bottom rung strategies or tools will be appropriate. In practice multiple strategies and tools will be needed to address the problems. This is now well established in the pollution domain where tool packages (standards, economic incentives, information, self regulation) have to be assembled to produce an effective response to pollution damage and risk. Additionally, it has to be recognised that risk strategies have to be viewed dynamically to reflect both changing economic, political and social conditions and new knowledge or technological developments.

The rational expectation would be that national governments would only take direct action if, for instance, risks were collectively consumed on a very large scale, when potential risk displacement or spread was a countrywide phenomeon, where individuals had highly constrained opt-out options and where individuals or communities were deterred from making private safety provisions because they could not exclude free loaders.

## Figure 3: Ladders of Intervention

| *Location of Authority* | *Mitigation Strategy* | *Policy Tool* |
|---|---|---|
| Transnational Body | Hazard Avoidance<br>(remove hazard source) | Bans on hazard production |
| National Government<br>(Government Department or<br>quasi-independent Specialist<br>Agency)* | 'Hard' Hazard Reduction<br>(structural measures)<br>: to reduce risk generation<br>'Soft' Hazard Reduction<br>(catchment controls) | Command and Control Regulation<br>: to require safety provision<br>: to require risk pooling |
| Regional Government or<br>Specialist Agency* | Coercive Vulnerability Reduction<br>(land use zoning, building regs) | Economic Incentives<br>for:– safety provision<br>: reduced risk generation<br>: vulnerability reduction |
| Regional Coordination Councils | Vulnerability Reduction by<br>discretionary Community choice<br>and collective action | : risk avoidance<br>: risk pooling |
| Local Government or Specialist<br>Agency* | | |
| Communities | Risk Pooling compulsory<br>voluntary | Information Provision<br>to allow private choice |
| Individuals | Loss Bearing or Sharing | |
| | Post Event Harm Alleviation | |

*Agencies could be private sector or PPPs

Typically, however, in the water sector the bias has been towards the top of the ladders with most emphasis placed on national decision making, the use of hard hazard reduction measures and coercive command and control regulation. It is, of course true to say that loss bearing and the alleviation of suffering after the hazard event has also been widely adopted but largely by default when conventional measures have failed or lack of resources (financial and human) have precluded action. This is not the same as consciously choosing and planning for a loss bearing option after analysis has either demonstrated that the costs of risk mitigation outweigh the benefits or that communities have a greater capacity to cope with loss than to improve safety.

Even in the flood risk case, where alternative approaches have been advocated for well over 50 years the bias towards top down structural control remains. In England, for example, it has just been reported that house builders have almost doubled the numbers of homes they are developing in flood zones in a year, despite the fact that many parts of the country suffered from widespread flooding only last year (The Times, Saturday October 27$^{th}$, 2001). This has occurred even though local governments have extensive land zoning and development control powers. According to the Local Government Association, rather than exercising these powers "local authorities should be pushing the provision of better flood defences way up the political agenda". Local authorities are frequently under considerable pressure to promote development rather than restrict it, but their preference for defence is also a learnt response from conventional practice and is a product of a risk management regime which ensures that defence is paid for nationally but the costs of zoning controls are borne locally. Removal of this preference bias could be attempted by abolishing the effective subsidies for structural risk controls, by ensuring that housebuilders and local authorities bear the risk costs (provide insurance or bonds) and by providing clear risk information at the time of land or house sales.

The whole question of the relative merits of the coercive top down and the discretionary collaborative management approaches has been explored by May *et al* 1996 in a comparative study of policies in the United States and New Zealand. They argue that in some parts of the

United States, state governments (sometimes following requirements imposed by the Federal Government) have directed local governments to protect environmentally sensitive or hazardous areas in ways which have been perceived as overly prescriptive and coercive. Failure of higher-level governments to fund the costs of implementation, the lack of flexibility in the required actions and the shifting of political blame for infringement of property rights have, according to May *et al* (1996) led local governments to be reluctant partners in the risk management exercise.

Such coercive approaches were also common place in New Zealand until the 1984 political and economic reforms, which shifted the management of the economy to a much more free-market system. In the resources and environmental domains, more attention was paid to enhancing capacity and providing incentives. New regional councils were given the role of strategically managing the natural resource in their areas in a sustainable and integrated manner, public participation in decision-making and mechanisms for conflict resolution were introduced, and the emphasis in legislation shifted to outcomes rather than prescriptions about the methods to be used to achieve such outcomes. Importantly subsidies which “biased” decision making towards structural risk control approaches were abolished and replaced (in part) by technical assistance and funding to help plan making, consultation and co-operation. It would be helpful to see whether this more delegated, co-operative approach has improved risk management, in the sense of gearing expenditures more closely to social priorities over which risks to curb or to accept.

### Transactions Costs

Transactions costs are one source of market failure which explain why private risk markets have not emerged or operate extremely poorly. Reducing these transactions costs by providing the information upon which individuals or communities can make their own risk choices has already been discussed. However, transactions costs are also important in the choice of the most cost effective risk management strategies, policy tools and decision principles.

In some cases individuals, community groups or lower tiers of government cannot make socially desirable risk management decisions because of transaction cost barriers erected by the national government. We have already seen one case of this in the flood example, where government has biased the choice of mitigation strategy by funding one method from national taxation but not providing similar help to implement risk pooling or vulnerability reduction. In other words there is not a level choice playing field and the appropriate policy response may be to either remove all forms of subsidy or to equalise subsidy levels across all types of strategy.

Another example occurs when property rights or water licensing provisions do not allow separate markets to emerge in which risks and security can be traded. Water scarcity risks, for instance, could be, and indeed have been, reduced by separating land and water rights so allowing them to be independently traded. Trades may involve the permanent transfer of rights or could take the form of options, whereby a municipality or indeed large industry, could pay for the right to take over a supply during critical shortage periods. The presumption is that the sellers of the rights will only trade if the sale yields more than the potential harms generated by the increased scarcity hazards they now face and/or that they have relatively low cost means of reducing their vulnerability. However, as noted previously deregulation to allow private choices may have to be accompanied by regulations to protect third party users of the multi-purpose water resource.

Consideration of the transactions costs involved in implementing different strategies or using different tools is clearly vital in making efficient policy choices. If, for instance, the creators of a pollution hazard are many, dispersed and possibly unknown then it may be extremely costly to monitor a command and control system which sets discharge standards; indeed such a system may be impossible to implement if the culture of the society does not encourage compliance. In such cases it may be more effective to tackle the potential harm rather than the source of the hazard. Similarly, it is a well know adage that risks should be allocated to those most able to deal with them, and there will be cases where hazard generators do not have the capacity to curb their generating activities. One example, where implementation effectiveness runs counter to that of the polluter pays principle is the case of the harms created by lake acidification in Scandinavia. The costs of increasing the buffering capacity of the lakes through liming are low compared to those involved in attempting to tackle the international pollution sources and moreover the time taken to address the harm is reduced significantly.

Full analysis of the transaction costs will also need to include an assessment of whether a policy tool can be effective on its own. The introduction of market incentives or delegated choice making to communities are clearly unlikely to work if information and capacity building help is not provided at the same time.

## 6. Multiple Organisations

Although the segmented and sub-sectoral approach to water resources management has undoubtedly reduced our capacity to deal with multiple risks in an holistic manner; it does not follow that creating multifunctional integrated agencies (e.g. River Basin Management Authorities) will automatically provide a solution. In fact it can be argued that the creation of such agencies is often merely a continuation of top-down thinking with water professionals having the key role in trade-off decision making. This most obviously applies when the agency (be it a national department or specialist resource management, conservation or environmental protection authority) is “closed” and does not have meaningful engagement with stakeholders. The risk management options and outcomes will reflect the way functional priorities are established within the agency and on the professional training of its staff. Conflicts of interest are now hidden within the organisation and the battle over priorities takes place out of public view. In all such cases real holistic risk management will not occur if, as is common, one function, one set of professional values and one set of interests come to dominate the organisation.

Holistic risk management inevitably involves some risk generators, risk takers or buyers of safety having to sacrifice their own interests for a broader common good. This means that to be effective risk management has to include decision making and conflict resolution mechanisms which involve the risk generators, those at risk from harm and the various gate-keeper organisations that seek to regulate risks or provide safety. Even for a single specific risk, management has to involve several organisations (public and private) working with different political, social or economic pressures on them. If full recognition is given to risk trade offs and cross sectoral risk shifting possibilities then inevitably even more organisations will need to have some input into decision making.

As May *et al* 1996 have pointed out in some countries and policy domains the perceived failure of top down coercive regulation has led to the exploration of various collaborative models (co-production, collaborative planning, citizens juries, co-operative discourse and other forms of civic environmentalism). Many of the attempts at co-operation, concensus building and participatory priority setting have arisen from efforts to implement Local Agenda 21 following the Rio Conference.

There are cases where such methods have reportedly been successful in resolving risk trade off conflicts, even when one group has to make very clear sacrifices for the wider public good. Jaeger *et al* (2001) give the example of the need to find a location for a new solid waste landfill site in an area of Switzerland already affected by water and soil pollution from existing landfills. Citizens panels were formed from the communities near the various potential sites (chosen on geological, hydrological and economic grounds) and a concensus on the socially preferred site was reached. Interestingly this site was not the first choice of the "experts" from the Canton's building department. Although Ostrom work (1990, 1996) has suggested that communities have the capacity to manage their own water use trade off problems, it appears to be the case that the planned use of more collaborative decision making models has had only limited impact to date on risk management in the water sector.

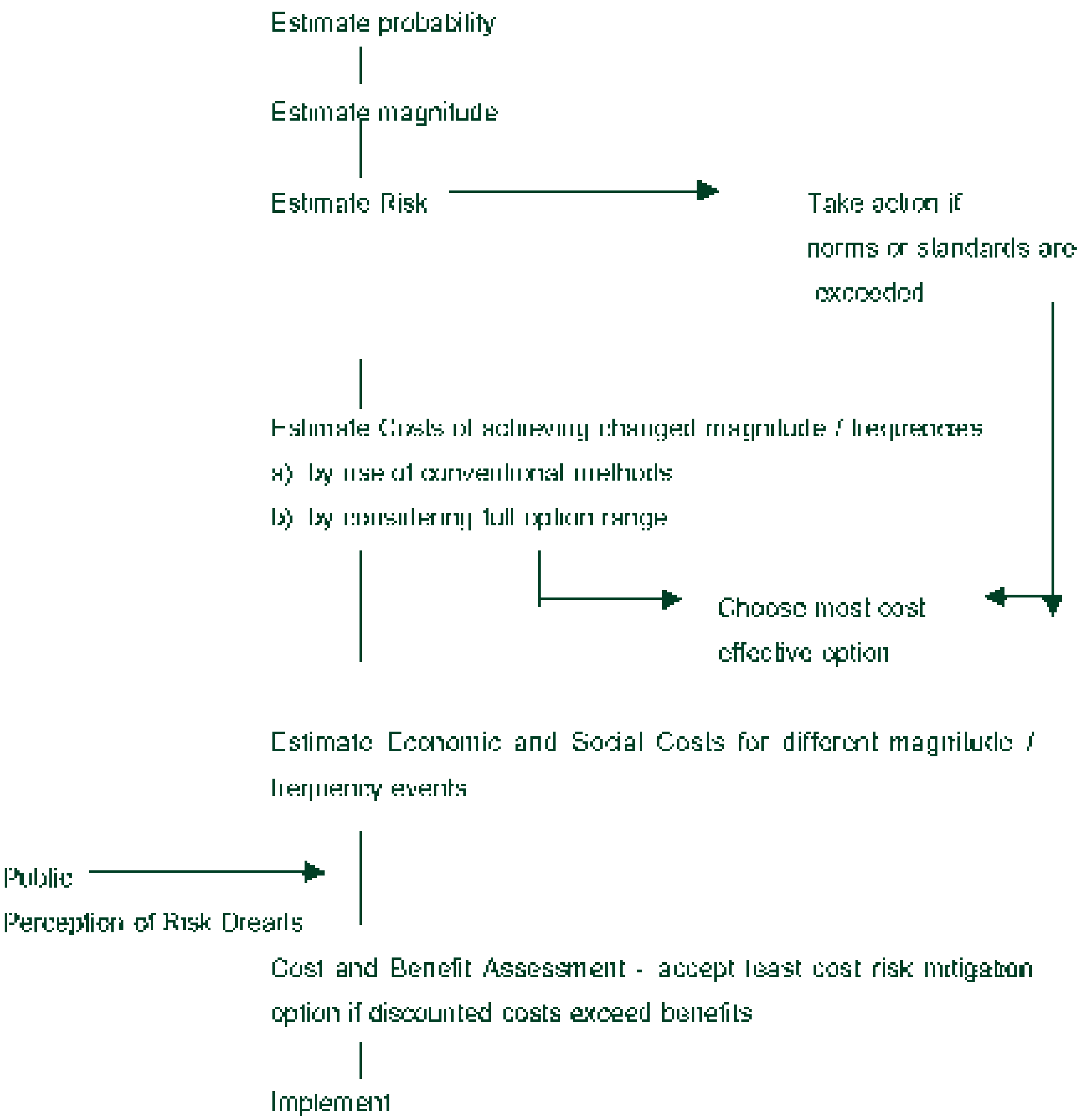
Although organisational responses through collaborative and partnership mechanisms are one way of involving stakeholders in decision-making it has to be stressed that participation is not always an unmitigated good. As Rydin and Pennington (2000) state analysis of participation exercises in practice has tended to produce very mixed results. Many policy analysts have highlighted the propensity for participatory organisations to be captured by powerful interest groups, while others have stressed that providing incentives for or reducing the disincentives for co-operative behaviour plays a vital role in successful participation, (Rydin and Pennington 2000). In addition, for collaborative fora to be effective they have to be accompanied by strategies for building social capital. Lam (1996) in his study of the Taiwanese irrigation system has suggested a whole range of measures or institutions which are important in creating and maintaining the social capital necessary for effective co-operative decision-making and action.

It should also be noted that for some forms of risk, where for instance, decision-makers are numerous and scattered widely, participatory approaches are impractical. In addition, this is also likely to be the case when stakeholder “catchments” do not coincide, trade-offs between water, air and land pollution risks are an example here. It may be more appropriate for Governments to employ market type institutions which “value” the relevant risks and make all decision makers aware of the risk costs imposed on others by their actions. Clearly many of the risk generators or magnifers will be outside the water sector, however water managers themselves will also need to be more aware of their role in generating hazards; hazards which at least in the pollution case can be transferred to other environmental media. Managers both inside and outside the sector will need to pay more attention to undertaking risk assessments as an integral part of plan or policy making. However, for such assessments to be meaningful in social welfare terms they will need to incorporate public preferences and values.

## *7. Risk Assessment Methods*

The conventional "scientific" approach to establishing whether a potential risk problem should be tackled by what methods involves several stages, although not all are always included.

Figure 4: The risk assessment process



For some risk types the risk assessment process effectively ends at stage 3; once a norm or standard has been exceeded conventional methods of risk regulation come into play and typically there is no public involvement in establishing the norms and standards.

Although recently, some scientifically trained risk analysts have recognised that public perceptions of risk dreads should play a role in social cost calculations, it is not yet evident that this has had much practical input into the water related risk assessment process. Unless the cost and benefit assessment stage employs weighting techniques to give priority to specific groups (e.g. those on very low incomes) the distribution of welfare arising from the action and option choices has no relevance in the scientific decision process. It would not matter if all the benefits of risk mitigation were given to the citizens of the nation's capital or those in the highest income groups as long as the CBA produced the correct result. Equity is not a likely outcome of such a process since inevitably cost benefit assessments favour the defence of high value properties.

It is, of course, axiomatic that this scientific and econocratic approach to risk management decisions is leavened by political interests but it is nevertheless highly influential. Moreover, some would argue that in today's risk society, the scientific approach is actually gaining favour as governments seek to absolve themselves of blame for harms. If decisions are based on the "best scientific evidence" or passed to a supposedly neutral expert committee political risks to governments are reduced.

During the risk assessment process the question of how the finance will be raised to implement the chosen safety measures is at best a secondary issue. Moreover, who will pay the investment costs and who will continue to run the risk of harm is barely considered. And yet, from a social perspective on risk, it would be impossible for individual judgements to be made about risk acceptability unless they knew the trade offs they were making. In some areas customers can make clear choices (e.g. to reduce "food" risks by buying organic products at higher prices) but in the water sector individuals rarely have such opportunities. Clearly in some cases this arises from the technical characteristics of the resource or service, but in others it arises because little attempt has been made to consider risk management as an economic good, subject to social choice processes. The challenge is how to shift thinking about risk in the water sector, to change the culture from dependency on others to make safety choices into one where communities and individuals can take responsibility. In other words rather than assuming that all risk should be managed as a public good, efforts need to be made to identify those areas where it is or could be a private good.

It is of course, easier to say that risk management should be a social choice process than it is to make it so. One difficulty is that if risk is to be treated as a social construct, defined as the dangers that societies regard as troublesome, then it is not a static component of an activity or situation. It is a variable which cannot be measured on a once and for all basis, rather it changes with Knowledge, economic and socio-cultural conditions. Risk is therefore highly dynamic and is likely to change much more rapidly than changes to 'natural' hazard probabilities.

Numerous studies have established that riskiness, as perceived and dreaded by the public, differs markedly from risk as measured by magnitude/frequency equations. Figure 5, taken from Vlek 1996 lists the eleven basic elements underlying perceived riskiness. Some, but by no means all, are consistent with those employed in conventional risk equations. However, it is important that two of these elements – controllability and voluntariness of exposure – reinforce the argument in this paper that subsidiarity and involvement in decision making are crucial to effective risk management. Moreover, it is significant that perceptual studies have emphasised that riskiness is perceived relative to the expected benefits and to the distribution of risks and benefits; in other words risk acceptability is not an absolute but will vary with perceptions of fairness and justice.

Figure 5: Basic dimensions underlying perceived riskiness

1. Potential degree of harm or fatality
2. Physical extent of damage (area affected)
3. Social extent of damage (number of people involved)
4. Time distribution of damage (immediate and/or delayed effects)
5. Probability of undesired consequence
6. Controllability (by self or trusted expert) of consequences
7. Experience with, familiarity, imaginability of consequences
8. Voluntariness of exposure (freedom of choice)
9. Clarity, importance of expected benefits
10. Social distribution of risks and benefits
11. Harmful intentionality

There are now models and one known case of their implementation (The Health Council of the Netherlands, cited in Vlek 1996) where the conventional risk assessment process is in effect inverted to place the human context, knowledge, need and preferences as the first assessment stage. Evaluation then takes place of the alternative courses of action potentially available to address these needs and preferences, recognising that each intervention option produces a different social distribution of the benefits and remaining risks. The evaluation also explicitly recognises that all interventions have unintended and potentially harmful effects. Such ‘inverted’ risk assessment models would appear to have a useful role to play in the water sector to ensure that risk management becomes more demand responsive, more inclusive in terms of mitigation options and more aware that risk mitigation itself can simply shift risks or create new forms of risk. There are also techniques (stated preference or choice modelling) which allow us to weight up the benefits of reducing one type of risk against both the costs of the reduction and the relative deterioration in safety from other forms of risk which capital constraints imply.

All these techniques are far from perfect and are expensive to employ. However, millions of pounds are spent on collecting climatic and hydrological data in order to calculate hazard probabilities, it cannot be too much to ask that a fraction of this expenditure goes into assessing public risk trade-off preferences, the real demands for safety, socially possible risk mitigation strategies and the acceptability and effectiveness of non-conventional policy tools. Moreover, unless the deficiencies in our understanding of the social dimensions of risk are addressed, attention will remain firmly fixed on managing the hazard rather than on maximizing the social and economic benefits derived from risk mitigation efforts.

## *8. The Distributional Question – Some Concluding Remarks*

People take risks routinely as part of everyday life to gain economic and social advantages, or indeed just for pure pleasure. Many such risks are essentially unregulated and individual private choices govern what hazardous activities are pursued and what vulnerability reduction measures are adopted. It is, of course, true that poor people may have limited options to avoid risks; they are forced to live and work in hazardous conditions in order to have a livelihood at all. However, even the poorest communities can and have developed vulnerability reduction measures and coping strategies to protect themselves.

The technology based water sector has, however, become characteristically one in which it has been assumed that risks are public "bads", risk mitigation is a public good and where professional judgements (albeit tempered by politics) govern risk mitigation practice. There are clearly good reasons why this approach to risk management has developed over time. The multipurpose hydrologically interconnected nature of the resource, the existence of common property features, the natural monopoly in much service provision and the need to safeguard public health are just some of these reasons. However, there are also good reasons why it is now worth questioning whether conventional practices represent an appropriate and sustainable strategy for all water related risks, particularly given the major financial and human capacity constraints under which the sector operates.

One important factor which suggests that a review of practice is long overdue is the clear existence of a *safety and subsidy "snowball";* a snowball which inexorably accumulates in a number of related ways. Once risk reduction is seen as someone else's responsibility, private or community based mechanisms for reducing vulnerability to hazards tend to fall into disuse; people develop a dependency culture and over rely on governments to provide security for them. Likewise, once safety has been provided to say one flood prone settlement, relative disadvantage is perceived by those still unprotected and demands to be included in hazard reduction projects escalate. The safety provision treadmill gets worse if defence for one area deflects risk elsewhere, potentially in magnified form; this is commonly the case for floods, urban drainage and coastal defence. The tendency for snowball accumulation is further reinforced if publically provided safety comes at no or low cost to the beneficiaries, whereas private or community based vulnerability reduction still has to be paid for at full cost. Still further accumulation occurs when publically provided safety encourages more people to place themselves in hazardous positions; the private risk cost and benefit equation has been changed, individuals now perceive that they can, for example, occupy flood plains and gain the advantage of cheaper housing without paying the risk costs.

When the accumulating demands for governments to provide safety are placed alongside the conventional bias towards providing safety through structural adjustments to the hazard, the problems arising from current practice become still more evident. Although for some hazards, technology can reduce risk to virtually zero (impurities in drinking water for example) it can only do so at a high cost; a cost which inevitably means that other possibly much more highly valued goods and services cannot be provided. However, for other hazards, the technological solutions reduce the probability of medium to high frequency events but do not tackle the low frequency, high magnitude event; the “solution”, by not considering vulverability may, therefore, actually increase risk.

There is no intention here to question the motives of water professionals; they have usually employed their professional expertise in ways they believe benefit society. However, in making supposedly “neutral” professional judgements they have frequently failed to perceive that they are actually making significant decisions about the allocation of real income and welfare within an economy. It is now very well accepted that different risk mitigation priorities, strategies and policy instruments are not neutral in their allocation of risk costs and mitigation benefits. Current practices involve large scale direct and cross-subsidy flows which are often not recognised when policies, plans and projects are developed. Such subsidies might be socially and politically justifiable, but in many cases they appear to be the unconsidered outcomes of conventional practice rather than intended and focussed attempts to address social welfare needs.

In this paper it has been argued that risk is a socially defined concept and that there is a need for the water sector to consider it as such. Much more attention needs to be paid to instruments and institutions which allow individuals and communities to express their own risk mitigation preferences, and which make hazard generators much more aware of the risks they impose on others. Greater attention also needs to be paid to the whole range of mitigation strategies to produce a more cost-effective approach to safety provision.

It has been suggested that risk management decision making has to be informed by thinking from an economic and social perspective. It cannot be driven solely by top down institutions designed on the basis of the physical nature of the hazard and the technological means of regulating that hazard. Once it is accepted that risk management is a distributive question, which involves complex trade off options, then it becomes clear that a more demand driven approach is needed. Such an approach has to be based on a clear understanding of the economic characteristics of the risks, of public preferences and of societies' willingness and capacity to adopt different risk mitigation strategies. Of necessity considerable effort will need to be made to develop the social capital which is vital for the implementation of sustainable, effective and welfare orientated risk management.

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