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DEVELOPMENTS IN FLOODPLAIN RISK MANAGEMENT: DECISION-MAKING IN ENGLAND AND WALES

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INTRODUCTION

Natural floodplains are unique and valuable habitats which provide a vital morphological and ecological transition from the hills to the main river channel, and are favoured as habitat by humans and wildlife alike. The morphological uniqueness of each river and its floodplains have been achieved throughout millennia (without the influence of human activities throughout the catchment, such as clearcutting, agro-industry, transportation infrastructure, housing and other developments). While exploiting floodplains, Mankind has, until relatively recently - the last century, perhaps - tended to respect the constraints implied by natural forces and the husbandry of natural resources (Newson, 1992). So, in rural areas in the UK, floodplains (especially in lowland river systems) were recognised as ideal for pasture, and where towns occupied floodplain areas, the dangers of flooding were recognised, property being generally built on the islands of higher ground.

In this century, however, rapid population increase in urban areas has brought pressure on development and food production, with a concomitant increase in road transport and other infrastructure. Floodplains are soft targets for greenfield development, with inadequate protection against determined developers. In the rush for material possessions, homage to the credo of competition, social acceptance of the profit motive and the calculus of short-term economics, and belief in technical deliverance from any and every problem, we seem to be losing our community, its sense of place and common understanding of the needs of - and our need for - the natural environment.

Today husbandry of our environment, and the inherited skills of working with nature and benefiting from its bounty, have been all but lost; the heritage of river corridors we might have enjoyed has been decimated by agro-business, transportation and property development. This paradigm shift is clearly portrayed in Chekov's The Cherry Orchard. What cruel irony there is in the quiet line delivered by the old and faithful butler Firs, who remarks that money used to be made from picking and processing the cherries - but that no-one could remember how to do that anymore. The cherry orchard is cut down and replaced by Summer Houses for those who can afford them.

The publication of Agenda 21 following the 'Earth Summit' at Rio de Janeiro in 1992 is likely to encourage LAs into natural resources planning to achieve the objective of sustainable development. In the United Kingdom, it is acknowledged that changes in policy direction and institutional arrangements are needed (LGMB, 1993). There is much that can be done, not least in improving the management of floodplains, through a partnership approach between LAs and other organisations such as the new Environment Agency (the Agency), which in April 1966 combined the National Rivers Authority (NRA), Her Majesty's Inspector of Pollution (HMIP), Waste Regulation and some activities of the Water Directorate in the Department of the Environment.

This paper addresses some of the issues and activities involved in progressing towards a more sustainable river environment, based on many years practical experience in the management of the Thames river catchment, its floodplains and flood defence. It should be emphasised that floodplains are sensitive to the land use management of their river catchment, and are considered here within that context. The response of NRA Thames Region (NRATR) to the challenge of sustainable development for the water environment (Gardiner, 1994a) is summarised, including recent work on identifying environmental capacity. Some of the material relates to practical operations in detail, in the belief that institutional arrangements in England and Wales are analogous to those in most

countries; so often, it is the operational detail which determines the level of environmental benefit achieved.

FLOODPLAIN DEVELOPMENT - EXAMPLES FROM THE ROYAL RIVER THAMES

The primacy of development paradigm is everywhere expressed in asphalt, bricks and concrete. In the Thames floodplain and at risk from the 1-in-100-year flood, there are some 4,500 properties between Cookham and Eton, and as many as 17,000 properties between Datchet and Walton Bridge, despite consistent advice against floodplain development from the statutory authorities, i.e. the Thames Conservancy (until 1974), Thames Water (until 1989) and the NRATR (until 1996). None of these authorities have had the power to veto development on the grounds of flood risk; their powers have been confined to creating bylaws, which restrict development of riparian strips usually only 8m from the riverbank (16m in tidal areas), and prohibiting filling in the floodplain (but this can be overcome by the granting of planning permission).

The conversion of floodplain to built environment, whether wholesale or insidious, has therefore occurred in the UK as elsewhere in the world, dictated by short-term economics mixed with political expediency and inadequate legislative or planning control It continues today, with examples of deliberate disregard for the local planning authority (LPA) by developers, and even for the statutory consultee by the LPA, being experienced in the Thames floodplain well within the last decade. There is usually no time (between the LPA officer s planning recommendation on a proposal and its determination by the Planning Committee) for an appeal to the Secretary of State for determination of the latter case. On a recent and rare occasion, an appeal was made on the basis that it was such a blatant attempt at railroading floodplain development through, was turned down because it was held not to be a sufficiently strategic issue. Perhaps the relatively recent Memorandum of Agreement between the NRA and the Association of Local Authorities, together with the Section 105 Surveys being undertaken by the NRA (now absorbed into the Environment Agency, or The Agency) will help to improve understanding in this area.

Experience has shown often that only through timely information and swift, determined actions by individuals is the floodplain protected from illegal or unconsented activities. In the mid-1980s, a bold, round-the-clock, 3-day continuous excavation of material illegally dumped in the Thames floodplain was carried out by Thames Water Rivers Division under police protection (those responsible for the tipping were known to possess a shotgun). However, in the early 90s, fast and massive filling to level the floodplain for private polo pitches proved unstoppable. To remove it all would have caused even more damage; protracted negotiations resulted in the developer agreeing to pay for mathematical modelling of the Thames and the effect of the filling on flood flows, followed by environmental mitigation measures and improvement of the flood risk to a few houses in the area, some L500,000 worth of work. Nonetheless, the insidious process of incremental loss of natural floodplain continues

While some may have rejoiced in the actions taken by the authorities, they did not stop environmental damage being caused, and illustrate the weakness of floodplain protection and the need for robust negotiation with those who claim ignorance of, or have the money and power to ignore, the land use planning system. River corridors have been subjected to many land use changes which have ignored or discounted the environment as of little value; the community has been disconnected with its natural environment, and as a result we have lost much of the morphological equilibrium and ecological value of our riverine heritage. It may be instructive to look at some further reasons behind this national disaster, sadly not limited to the UK.

INSTITUTIONAL ISSUES IN DEVELOPMENT PLANNING AND CONTROL

LPAs owning land within the 1-in-100 year floodplain can be most reluctant to include policies in their development plan aimed at restricting the development of such land; in one case, only the 1-in-25 year floodplain limit could be included for this reason. The LA hope was that land prices would increase to the point that it would be financially worthwhile for enough fill to be imported to raise the land above the 1-in-100 year flood level. It is difficult to prove that a specific floodplain infilling is responsible for any increase in flood risk elsewhere, so it is rare for anyone to be

sued for infilling the floodplain and increasing the flood risk to their neighbours. Equally, it is rare for a change in surface runoff regime (usually caused by change in land use) in the catchment to be held legally responsible for increased flood risk downstream.

It has been shown that there has been poor institutional coherence over building in the floodplain. Elsewhere in the catchment, the situation is little different in terms of institutional diffidence over surface water management. Urbanisation and other land use changes have increased the volume and speed of runoff, with little consideration being given to the strategic effects on river channel and floodplains downstream. The philosophy has been one of surface water drainage, treating water as a waste product for rapid disposal, rather than surface water management, which regards water as a valuable natural resource. There are exceptions, including the carefully-planned new towns such as Swindon, Bracknell and Milton Keynes, where balancing lakes have been installed in an attempt to maintain the shape of the hydrograph passing downstream. But it is only in this decade that guidance for including water quality in storage pond design has been published (CIRIA, 1993).

The UK has yet to adopt national policies mandating (or even recommending) source control techniques such as grass swales and infiltration areas, which maintain the water cycle as closely as possible at the point of rainfall (HRDL, 1993). Many examples can be found abroad, in addition to storage ponds with vegetative treatment at the inlet and outlet to ensure good water quality downstream. It is ironic that the UK, proud of its strong system of development planning and control, has so much to learn from other countries practising source control (eg. Japan, Sweden, France, Germany, Canada etc., as well as the USA), many of which have far less effective land use control.

In general, LAs in England and Wales have been responsible for urban land drainage as well as foul sewerage Their statutory consultee authorities have had little expertise and no direct control over the arrangements for surface water management (i.e sewerage) in urban areas. In England and Wales, the main-river limit (MRL) distinguishes not only the limit of operational responsibility but also the limit of the The Agency's land drainage consenting powers over works to bed, banks or flow ; only culverting and damming are subject to consent upstream of MRL. Outfalls from urban surface water drains have more often been to ordinary (previously non-main) watercourses, under the powers of LAs, than to designated main river

Some LAs have strenuously denied their responsibilities for either river maintenance or capital works, despite clear wording in the various water acts, and relatively few have had significant budgets for land drainage maintenance. Many have no budget allocation, and yet there is a far greater length of ordinary watercourse than designated main river. Even on main river, the Agency and its forebears have been given no powers to control outflows from surface water sewers, other than for dilution, i.e. water quality, purposes. Without such powers, and with few local authority resources, how can co-ordinated surface water management be achieved throughout the catchment to protect downstream floodplains?

The extent of the neglect of our watercourses in terms of control through Land Drainage Consent powers has been recorded by Day and Fenner (1996), and is a matter of considerable concern While this situation continues, much will depend on close co-operation between the Agency, LAs and the privatised Water Utilities. Co-ordination between the Utilities asset management plans and development plans can be sponsored by the process of integrated catchment management planning (ICMP). However, the success of the teamwork will depend on the focus of the Water Utilities being as much or more on benefits for their stakeholders (i.e. on long-term benefits) as on their shareholders. This means, for example, that the team's decisions over storage ponds, let alone source control techniques, should conform with the needs of the catchment stakeholders, rather than be the cheapest option for their shareholders.

TO CONSERVE AND ENHANCE - A MULTI-FUNCTIONAL OPPORTUNITY LOST?

The control of outfall quantity, among other benefits to the water environment, is only effected in some of the eight Agency Regions in England and Wales through negotiation on the basis of the developer s requirement for land drainage consent. Other NRA functions (i.e. Water Quality, Water

Resources, Fisheries, Navigation, Conservation and Recreation), did not pursue this obvious aspect of the duty to conserve and enhance natural beauty, etc., in their licensing arrangements. In stark contrast to the neglect recorded by Day and Fenner (1996), vigorous use of the Land Drainage Consent procedures (Howarth and McGillivray, 1996) can produce results highly beneficial to the environment. Surface water management, buffer zones and river corridor enhancement, together with more environmentally sensitive improvements in flood defence, were achieved - some L32 million in 1992 (including L11.6 million environmental enhancements), measured as the cost of the work involved, and not including the value of all the mitigation measures negotiated in planning and design of the development proposal. These negotiated changes often made a significant financial savings to the developer over the original design.

By the late 80s, it became apparent that, although this ICMP approach benefited all NRA functions, no one function was likely to give it first priority. It is as though the functions were legs supporting a table representing the catchment, the small area of tabletop immediately above the legs containing all the top priority, single-function activities. Meanwhile, the vast area of tabletop in-between these small, leg-top areas, while being of interest to many functions, suffers from being second priority for any one function. If a multi-functional team in the NRA had been asked to consider the entire tabletop, identifying the value of activities such as buffer zones and source control by adding together their values to each function, the true priorities would have emerged. How likely is it that the single-function activities would have competed successfully against the multi-functional?

In 1996, separate funding for each function persists in the Agency. Virtually nil funding exists for Conservation, which survives on handouts from other functions, in particular Flood Defence (in Thames Region, down to L0.5 million from L1 million in 1994, although the capital works design process is now inherently more environmentally sensitive, and has a strict requirement for environmental assessment). This separate funding, together with most staff still being organised in functional groups rather than small, multi-functional teams, militates against proper valuation and planning of multi-functional activities.

An acid test of the 1994 reorganisation, (which de-centralised each Region in favour of multi-functional Areas), was the degree of multi-functional influence on developers. To those involved in the Thames initiative with LPAs and developers, it seemed that the immediate value of the multi-functional benefits should be enough to justify the resources needed, which if necessary should be taken from less cost-effective single function activities. There was a further value inherent in the preventative nature of the work. In preventing symptoms of uncontrolled runoff, the initiative yielded long-term savings in terms of obviating expensive remedies.

This acid test found the NRA generally wanting for lack of resources. The system evolved in NRATR was found to work well and produce remarkable results. While there may have been agreement that an ounce of such prevention might be worth a pound of cure, changing the institutional status quo was difficult (in terms of the functional allocation of scarce resources), to achieve the ounce. However, this system is well documented; the Agency could still become pro-active, to ensure that not all future opportunities, which occur daily, are lost. It appears that this situation is to be found in most countries of the world; much could be achieved if organisations adopted a truly multi-functional approach, internally and externally.

FLOOD DEFENCE, FLOODPLAIN MANAGEMENT AND LAND USE PLANNING

Uncontrolled surface water runoff has played a major role in worsening flood risk downstream (REF?). The socio-political pressure following floods has had the tendency in the UK and elsewhere to sponsor channelisation with consequent damage to river corridor geomorphology and ecology (Brookes, 1988). However, flood alleviation schemes will be carried out only where the benefits outweigh the costs, and the executive Regional Flood Defence Committees regard the 1-in-50-year standard of protection as a minimum. Because of the use of discounted cash flow, it is usually the damages that are incurred from the relatively more frequent floods, of up to the 1-in-5 year return period perhaps, which supply the major part of the benefits. It is these floods nearest to the threshold which are most exacerbated when runoff is uncontrolled. Yet economic analysis has yet to be applied to compare the benefits of source control against traditional flood alleviation schemes.

In the mid-80s, mathematical and physical modelling analysis showed that it was feasible to improve the standards of flood defence for major Thameside towns from Maidenhead down to Staines from an unacceptably low 1-in-5 year to a 1-in-65 year return period. An holistic approach pioneered on the Lower Colne Study was adopted for the UK s first Floodplain Management Plan (FMP), from Datchet to Walton Bridge on the River Thames (Gardiner, 1991 and 1992). This approach was taken in the light of extensive experience of single-function project appraisal (albeit environmentally sensitive and with extensive public consultation), including the major Maidenhead, Windsor and Eton Flood Alleviation Scheme (MWEFAS), now being implemented at some L70 million. The MWEFAS scheme had nothing to say about management of the floodplain, which was of course central to the FMP (from which could spring capital works to continue the MWEFAS downstream to Walton Bridge).

The holistic planning approach integrated far better with strategic and local land use planning in this hotbed of developers activity on the western outskirts of London, and confirmed that individual projects benefit from being embedded within a strategic land use plan. Experience also taught that influence on land use policy and decision-making is essential for environmentally-sensitive planning of works involving land in private ownership. In comparison with the benefit-cost justification for capital expenditure, it should be stated that land drainage maintenance expenditure is based on a notional house-equivalent value of floodplain property, a sliding scale from protection against a 1-in-1-year flood event for arable land.

So, from 1988, Thames Water's Rivers Division started to strengthen its Planning Liaison team by the inclusion of experienced planning professionals (Members of the Royal Town Planning Institute) and revised its approach to land use planning in four important ways. These were:

1. Definition and promotion (to LPAs) of thirteen model policies, couched in LPA language which covered all aspects of the water environment, including conservation of river corridors, with the objective of their inclusion in development plans.
2. All other aspects of communications with the LPAs were greatly improved at all levels.
3. A programme of river catchment plans for urban rivers was initiated, and
4. A tough negotiating stance was taken with developers, based usually on compliance with the provisions of the Land Drainage Act (LDA), 1976, and the Wildlife and Countryside Act (WCA), 1981, which required the authority to further conservation, etc. in land drainage.

This stance centred on the duty to conserve and enhance the environment (from the WCA), including a presumption against giving land drainage consents for culverting. After much legal debate in the NRA, it was finally agreed that land drainage consents could be refused if there was risk of damage to the environment, on the basis of the duty to conserve and enhance the same while carrying out any of their functions.

The formation of the National Rivers Authority in 1989 brought the opportunity to consolidate these pioneering efforts into national policy. Meanwhile, Thames Region made progress in measuring the effectiveness and efficiency in the Planning Liaison activity. This activity included strategic and forward planning, environmental assessment (applied to external developments) and development control, co-ordinated by the teams operating the Land Drainage Consents. An excellant monitoring system was devised which gave a conservative measure of output and recorded the remarkable results referred to above.

MEANS OF INFLUENCING LAND USE

Management of a piece of land will usually involve decisions made in respect of the use of that land in accordance with the desires of its owners, modified by three main factors.

1) Legislation,
2) Economic instruments, and
3) Development planning.

Of these three influences, only development planning is generally capable of exerting an influence to conserve the unique sense of place of the land in its environs. However, the education of LA planners in respect of the water environment is still in its infancy. Also, from enquiries made at the 1995 Town Planning Summer School in Exeter, most of the projects put in for planning

permission are not progressed along the holistic lines needed for proper consideration of the water environment or indeed sustainable development in general. Multi-functional teams communicating effectively with other stakeholders are, apparently, a rarity among developments seeking planning permission.

The planners must not shoulder the responsibility alone; there were many in the Agency and elsewhere whose training excluded the function of development planning, and who therefore failed to see its relevance to the wellbeing of the water environment. Wider appreciation of the issues and the stakeholders is needed, and can be achieved through the training piloted by Thames Region planning staff. The introduction of members of the Royal Town Planning Institute made a huge difference in Thames Region, not least in the pioneering of regional-scale sustainability strategy in the form of the publication Thames 21 , which received a warm welcome from the community it sought to serve as a local authority contribution to the Agenda 21 process.

In addition to the three main factors listed above, a fourth - community consensus - has been found to be effective (Gardiner, 1966), as in the local example of capacity planning below. Community participation is increasingly seen as a necessary component in decision-making for sustainable development. Experience in the major project appraisals (Lower Colne, MWEFAS and the FMP for the Datchet to Walton Bridge reaches of the River Thames) taught that involvement of the community can bring the following major benefits:

1. valuable information about historic (flood) events, including photographs and even film footage,
2. advance notice of who is likely to support or resist possible land use change,
3. help with keeping the community informed as the project progresses
4. ideas for possible options and unforeseen potential benefits
5. community ownership (and therefore protection) of the final result

Middlesex University's Flood Hazard Research Centre (FHRC) carried out an extensive programme of public perception of flood risk, the value of the riverine environment and the authority responsible for flood defence, in parallel with several contingent valuations (or public willingness to pay) for otherwise intangible benefits associated with flood defence. This series of studies, published either as reports to the NRA or as internal papers to the FHRC at its Enfield campus, proved an invaluable addition to an understanding community concerns and values, which is vital to an authority involved in the socio-political process of identifying flood defence investment acceptable to the community.

SUSTAINABLE DEVELOPMENT

Support for influencing land use decision-making in favour of the water environment came from the 'Earth Summit' Conference at Rio de Janeiro. Most countries supported the production of Agenda 21, which in Section 18 exhorts all states, by AD 2000, to:

have national action programmes for water management, based on catchment basins or sub- basins, and efficient water-use programmes. These could include integration of water resource planning with land use planning and other development and conservation activities, demand management through pricing or regulation, conservation, reuse and recycling of water.

For those with responsibilities for the implementation of Agenda 21, the challenge is not only to halt the decimation of natural habitat but also to enhance and rehabilitate our natural heritage. Central government may express good intent in support of this challenge, but needs to review with committment the nuts and bolts of the process, to progress beyond the seemingly endless reorganisation of the major players involved. At the higher planning level, acceptance of the need for strategic environmental assessment to establish what development should go where would promote a process more likely to deliver sustainable development than the current system (Gardiner, 1996).

The overall strategy adopted by NRATR in 1988/89 as shown in Figure 1 has been described in detail, including the use of catchment management plans (CMPs), by Gardiner (1990a; 1994b). The internal process of producing CMPs has been outlined by Davies (1992) and Chandler (1994), and is continually under review as experience is gained nationally. Valuable external review of CMPs and what influence they may be having on development plans, has been provided by a team of planners

and an experienced hydrologist at Newcastle University (Slater et al, 1994). The new Agency has renamed CMPs Local Environment Agency Plans .

The challenge then can be seen as how to operationalise the environmental and social dimensions of sustainable development in such a way that decisions are made which are environmentally sound and socially acceptable as well as being judged economically worthwhile (Gardiner, 1994b). However, when adopting the 'strong sustainability' approach in which environmental criteria are to be satisfied prior to economic and social criteria, the first priority must be to understand the nature of the catchment's environment.

ENVIRONMENTAL CARRYING CAPACITY

Catchment planning has been defined as an agreed strategy for realising the environmental potential of a catchment within prevailing economic and political constraints. Thus the CMP process may provide a vehicle to develop and implement the principles of sustainable development and environmental carrying capacity in respect of the management and use of the water environment. Floodplain planning can be regarded as a central feature of catchment planning, a pivot between catchment land use and the river itself: a last opportunity to buffer the effects of the former on the latter.

Some carrying capacities of river channels and floodplains can be readily identified from Tom Turner's vision of the various capacities of a river corridor (Turner, 1987):

a visual amenity, a recreation area, a fishery, a nature reserve, a water supply, a storm-detention area, a drainage network and a movement corridor for boats, walkers, cyclists and equestrians.'

What then is the difficulty in achieving such multi-objective management? Could not planning and design proceed on estimated figures for capacity limits in all these areas until more precise numbers were available through scientific inquiry? Closer inspection shows that such an approach has considerable difficulties; there are at least three dimensions of sustainable development to consider - environmental, social and economic - which may call for different options to be considered.

From experience in NRATR, calculating the carrying capacities of a particular catchment appears to require a catchment-wide view which can be assessed with knowledge of local conditions, both subjective and objective. A regional planning strategy may be seen as having several aspects, as seen in Figure 2), which will need support from agreements at local level over carrying capacities. These could be discussed at the Environmental Forum meetings being held by LPAs with stakeholders to discuss issues of inventory for future development. Clearly, the competence of the community in its overall decision-making will require the collaboration of organisations through the LAs democratic development planning process. Each organisation will need to have formulated its own vision which can be articulated in some detail and in plain language.

There is then an urgency to identify and define environmental carrying capacities in order to assess whether activities identified in development plans or catchment management plans are indeed sustainable. This is all the more necessary when we realise that global warming has to be taken into account as well as economic growth, especially for the water environment (Beven, 1993). However, the social dimension of sustainability implies a degree of ownership in the decision-making, in which the democratic process of local government provides for development planning.

CAPACITY PLANNING - A LOCAL EXAMPLE

The NRA has generally considered applications for mineral extraction on a piecemeal basis. However, the Cotswold Water Park in the west of the Thames catchment offered an opportunity to put forward a river floodplain land use strategy to the counties involved. To assist them in finding the balance between economic and environmental requirements of the community (stipulated in the draft Mineral Planning Guidance Note 6 issued by the Department of the Environment), NRATR developed a corporate, multi-functional view as guardian of the water environment.

To help this process, the following definitions and explanations (environmental capacity being definable in terms of Areas and Thresholds), were agreed:

* Environmental Capacity - The commonly accepted definition of sustainable development recognises that a certain level of human activities will undermine the environment's ability to renew itself, resulting in a decline in the quality and quantity of resources. The point at which development passes from being sustainable to unsustainable is known as the environmental capacity.
* Areas - may include conservation areas such as Sites of Special Scientific Interest (SSSIs), National Nature Reserves (NNRs), protected landscape areas such as National Parks and Areas of Outstanding Natural Beauty, floodplains and aquifer protection zones.
* Thresholds - defined as the limits to acceptable change in these areas or throughout the area as a whole. Examples include water quality objectives and air pollution levels. In the case of SSSIs, NNRs and National Parks which may have less quantifiable resources, the thresholds may relate to the type and scale of development which may be accepted without undermining the environmental value.

From an initial, multi-functional assessment of the area, an aim and six objectives were identified:
The Upper Thames Valley constitutes resources of great environmental, cultural and historic value. These are, however, resources which have been much altered by intense human activity and are still subject to very considerable development pressures. This development should be controlled in such a way that ensures environmentally sustainability. In particular, the exploitation of aggregates should not exceed the environmental capacity of the Cotswold Water Park area. The sensitivity of the landscape of the Upper Thames Valley and the strategic importance of the Thames Path National Trail in particular should be recognised and protected.

The NRATR in partnership with other interested agencies should contribute to the management of the Cotswold Water Park area in providing planning advice and resources to monitor its effective implementation in accordance with its statutory powers to ensure that areas of value are conserved, and those which have become degraded are enhanced. The NRATR should also take the necessary action to protect and improve water quality, to alleviate flooding and to manage water resources.
1. Protect and enhance the riverine environment, including the Thames Path National Trail.
2. Protect and enhance the landscape character and nature conservation value of the Upper Thames Valley.
3. Ensure existing flooding problems are alleviated, not aggravated; improve land drainage.
4 Manage water resources in the area to meet both local and regional requirements.
5. Protect the quality of water and ensure adequate pollution control measures are imposed.
6. Protect and promote navigation and recreation.

With regard to mineral winning, the strategy should be after-use led, the longer-term use of the land resource being taken as a prime consideration. Three zones were identified by a sieve method of strategic environmental assessment (SEA):

Zone 1: Areas adjacent to the River Thames where the NRA is likely to object to mineral extraction because of its effect on the river environment and the Thames National Trail

Zone 2. Areas outside the floodplain where mineral extraction followed by restoration to agriculture at a low level would be acceptable

Zone 3: Areas within the floodplain where extraction would be acceptable followed by restoration to diverse wildlife habitats including open water and wetland for nature conservation purposes.

The NRA's perception of a threshold was not, in this instance, an objective truth; it was a guideline for the decision-makers and subject to political debate. Nevertheless, the process holds promise as a means to integrate the many (Agency) functions in a transparent way and facilitate the wider community debate as to the interpretation of sustainable development.

This example of floodplain management planning clearly illustrates the potential for changing the impact of flooding; both gravel extraction (with mounds of overburden) and restoration (which must be mounded if the pit is used for waste disposal and then returned to agriculture) can remove large areas of floodplain and potentially block floodways, increasing the risk of flooding elsewhere.

There are plenty of examples in the literature of how structural adjustments in the floodplain

can provide improved standards of protection, and of how the understanding of fluvial geomorphology can predict floodways which should therefore be kept clear, but the problem has always been to convince the community to accept the advice. The identification of floodways, through monitoring flood events or computational modelling, as in the analysis of the Thames floodplain (Palmer and Harpin, 1988; Gardiner, 1992), provides a further opportunity to identify zones which are critical to the natural carrying capacity of the floodplain, as distinct from passive storage areas which may be zoned for other uses (while ensuring that the overall stock of capacity is maintained. It may be possible for measures elsewhere in the catchment to substitute for loss of passive storage, to maintain this stock.)

The value which the Cotswold Water Park approach adds to our understanding is that it seeks firstly to combine all the information available, and then to package it as a long-term vision for the area, to be discussed with other stakeholders (whose visions may vary) with the aim of agreeing the future land use in the area - which will then be articulated in a statutory document which must be adhered to unless material considerations suggest otherwise.

SUPPORTIVE TECHNIQUES

For catchment/floodplain planning, project development, interpretation of LPA development plans and individual planning applications in terms of surface water management, supporting techniques in addition to (S)EA include:

1. distributed hydrological modelling
2. dynamic river and floodplain modelling
3. geographical information systems (GIS)
4. econometric and digital ground modelling (automatic flood/damage mapping)
5. assessment of rainfall through radar, and advanced flood warning systems
6. public perception studies

All of these techniques have been employed in the Thames catchment (eg. Rylands and Lee, 1992) and the use of GIS and the various models for the UK's first draft floodplain management plan (for the River Thames floodplain from Windsor to Walton) has been described by Gardiner (1990b). The public perception studies have been mentioned above, but the penultimate technique listed should, however, be summarised.

Assessment of rainfall through radar is an important component of flood forecasting, warning and response systems (FFWRS), which are being widely employed in Europe to reduce material, human and cultural flood losses (Parker and Fordham, 1995) The Agency has legal powers to set up flood warning systems, and has recently taken over the responsibility for flood warning dissemination from the Police. The previous, rather imprecise sharing of responsiblity between NRA, Police and LAs led to poor delivery of warning to the public and tensions between the authorities.

The Agency has benefitted from a considerable investment made by the NRA in new technology; computer-based, real-time, rainfall-runoff forecasting methods use data from weather radar and field stations via telemetry The aim is to provide early estimation and a swift warning to key properties at risk.

CONCLUSIONS: MAKING A DIFFERENCE - SOME PRESCRIPTIONS FOR CHANGE

The river catchment is a hydrological, geomorphological and ecological continuum. Similarly, the catchment's water environment will reflect how flood defence, water quality, water supply, etc. is managed. Land use change which is apparently only a local disruption can nevertheless cause serious adverse change to the downstream system, if not upstream. Therefore floodplain management cannot be isolated from catchment management planning.

Thus it is necessary to influence decisions made over land use, as implied in Agenda 21 from the Earth Summit at Rio. One of the ways to cause change in the impact of downstream flooding is through source control at or near the point of rainfall. Instead of treating rainfall runoff as a nuisance to be disposed of quickly, techniques of retention and attenuation are used in accordance with a Master Drainage Plan, which can itself be the core of a multi-functional catchment

management plan.

There are then three distinct areas of interest:

1. the floodplain itself, including the effective floodplains of any ordinary watercourse (i.e. upstream of main river limit);
2. the areas of flood storage (which may include floodplain) and
3. source control areas (at or near the point of rainfall).

In none of these areas, urban or rural, is there satisfactory control in the UK, in terms of the interests of the water environment wielding adequate influence on decision-making. Floodplain management is actually dependent on the intelligent management of land use throughout the catchment. Land use is influenced most by legislation, development planning and economic instruments, i.e. incentives for a particular land use.

It has been shown (e.g. in NRATR) that much can be accomplished through close co-ordination with LPAs and the water utilities, and through tougher negotiations with developers. This negotiation was often focused on demonstrating to the developer the value of the environment that had been ignored or devastated in the proposals, which had been drawn up to gain a planning approval that usually had little or no concern over riverine habitat.

Monitoring achievement showed high enhancement value and significant savings to developers. Of course, as developers and their consultants learn from experience, this work should become less onerous for the authorities. But it requires initial empowerment from senior levels, strong co-ordination of the many Agency functions by the planning liaison staff, and careful training of the negotiators.

The inclusion of best management practice (BMP) in surface water management should be encouraged at the planning stage, through the development planning and control process. With appropriate legislative changes, they could be actively ensured through the building control and land drainage consent processes. The current CIRIA project to identify examples of BMPs should do much to encourage developers and consultants to use source control techniques. However, two legislative changes long overdue are:

1. the removal of the anachronistic main river limit (MRL) so far as land drainage consents are concerned (leaving MRL as the limit for the Agency's operational activities), and
2. the introduction of controls over the discharge quantity of surface water outfalls.

Both these changes would resonate well with the Agency's two sole existing duties in flood defence. to oversee activities on a catchment-wide basis and to conserve and enhance (and indeed to promote the conservation and enhancement of) the environment in carrying out its functions.

For years, argument has raged over whether and how to designate the floodplain limits within which no development takes place. This simplistic view of floodplain management has clearly failed to prevent serious flood damage or its potential. Where the floodplain is wide enough to have both flood routes and areas of static storage defined for the 1-in-100 year flood, the more pragmatic approach for the downstream reaches is to designate the flood routes (floodways) as areas where development is prohibited, and the static storage areas as areas where development may take place under certain specific conditions.

In the jargon of sustainable development, the floodways (providing the carrying capacity) would be designated critical natural capital and the static storage areas as constant (or substitutable) natural assets. In upstream reaches, storage may become critical natural capital, reflecting the hydrological zoning adopted in London. In the upper catchment, storage will always be required of a development. in the middle it may be required depending on the circumstances and in the lower catchment, storage is not required for flood defence purposes (Gardiner, 1990a).

The carrying capacity of the floodplain can provide environmental objectives for the catchment and drainage plans, and can also help in identifying zones for development. The method described for the Cotswold Water Park provides a model to define such development zones in accord with agreements over what constitutes critical natural capital , in terms of thresholds and areas.

The value of this model lies not only in the technical aspects which determine the type and spatial distribution of the natural capital, but also in the process of communication by which agreement is reached that the decision represents the best current understanding of what sustainable

development means in practice.

Adopting these few conclusions would do much to conserve the remaining floodplain heritage, and begin the process of rehabilitating the water environment throughout the catchment. Without such change of direction, further loss of biodiversity, water quality, riparian landscape amenity and recreation opportunities - as well as degradation in standards of flood defence - is inevitable. Purely in terms of floodplain management, computational models play a central role in flood forecasting, warning and response systems in England and Wales, and the Agency now has the responsibility for dissemination of warnings.

Rivers and their floodplains have a magic for people that has been captured in art and poetry for centuries, as well as being the most biodiverse and fertile elements recognised in landscape ecology. Their loss is therefore one of the best examples of the economic, social and ecological damage to the community's natural heritage done by commercial exploitation by individuals and organisations, without regard for the wellbeing of either the present community or future generations.

REFERENCES

Beven, K. (1993), Riverine Flooding in a Warmer Britain. in The Geographical Journal, 159 (2) pp.157-161.

Brookes, A. (1988), Channelised Rivers: Perspectives for Environmental Management. John Wiley & Son, Chichester, England.

Chandler, J. (1994), Integrated Catchment Management. J.IWEM 8(1), pp 93-97, London, England.

CIRIA (Construction Industry Research and Information Association), 1992. Scope for Control of Urban Runoff. CIRIA Reports 123 and 124, London, England.

CIRIA, (1993), Design of Flood Storage Reservoirs. Construction Industry Research and Information Association, Butterworth-Heinemann Ltd., London, England.

Davies, G.L. (1992), Catchment Management Planning in the National Rivers Authority of England and Wales. In Saul, A.J. (Ed.) Floods and flood management. Kluwer Academic Publishers, London, England.

Day, R A and Fenner, R.A. (1996), The Effectiveness of the Land-Drainage Consent System. J.IWEM, 10 (2), pp.111-118.

Gardiner. J.L. (1990a). River Catchment Planning for Land Drainage and the Environment. J IWEM, 4(5), pp 442-451, London, England.

Gardiner, J.L. (1990b), The River Thames Strategic Planning Initiative: Planning, a Model Influence. In White, W.R. (Ed.) International Conference on River Flood Hydraulics. John Wiley & Sons, Chichester, England

Gardiner, J.L (1991), (Ed.) River Projects and Conservation· A manual for holistic appraisal. John Wiley & Sons, Chichester, England.

Gardiner. J.L. (1992), The River Thames Strategic Flood Defence Initiative: a New Approach to Flood Control Measures. In Rossi, G., Harmancioglu, N.and

Yevjevich. V. (Eds.) Coping with floods. NATO Advanced Study Institute Series, Kluwer Academic Publishers, London, England.

Gardiner. J.L. (1994a), Sustainable development for river catchments. J.IWEM, 8(3), pp 308-320, London, England.

Gardiner. J.L. (1994b), Developing Flood Defence as a Sustainable Hazard Alleviation Measure. In Gardiner. J L., Yevjevich, V and Starosolski, U (Eds.) Defence from Floods and Floodplain Management Kluwer Academic Publishers, Dordrecht, The Netherlands.

Gardiner. J.L (1996), The Use of EIA in Delivering Sustainable Development through Integrated Water Management. European Water Pollution Control, 6(1), pp.50-59 Howarth, W. and McGillivray, D. (Eds) (1996). Land Drainage and Flood Defence Responsibilities. A practical guide. Institution of Civil Engineers, Thomas Telford, London, England.

HRDL, (1993), Urban Drainage: the Natural Way. Hydro Research and Development Ltd., Clevedon, England

LGMB, (1993), A Framework for Local Sustainability. Local Government Management Board,

Luton, England.
Newson, M.D. (1992), Land, Water and Development. Routledge, London, England. Parker, D.J. and Fordham, M. (1996), An Evaluation of Flood Forecasting, Warning and Response Systems in the European Union. Water Resources Management, 10: pp.279-302, Kluwer Academic Publishers, Dordrecht, The Netherlands.
Rylands, W.D. and Lee, J.K. (1992), The Possibility of an Integrated Approach to the Provision of Storage in the Thames Region of the NRA. In Saul, A.J. (Ed.) Floods and Flood Management. Kluwer Academic Publishers, London, England.
Slater, S., Marvin, S., and Newson, M.D. (1994), Land Use Planning and the Water Environment: a Review of Development Plans and Catchment Management Plans. Working Paper No. 24, Dept. of Town and Country Planning, University of Newcastle upon Tyne, England.
Turner, T. (1987), Landscape Planning. Hutchinson, London, England. JLG, 20 Sept 1996.

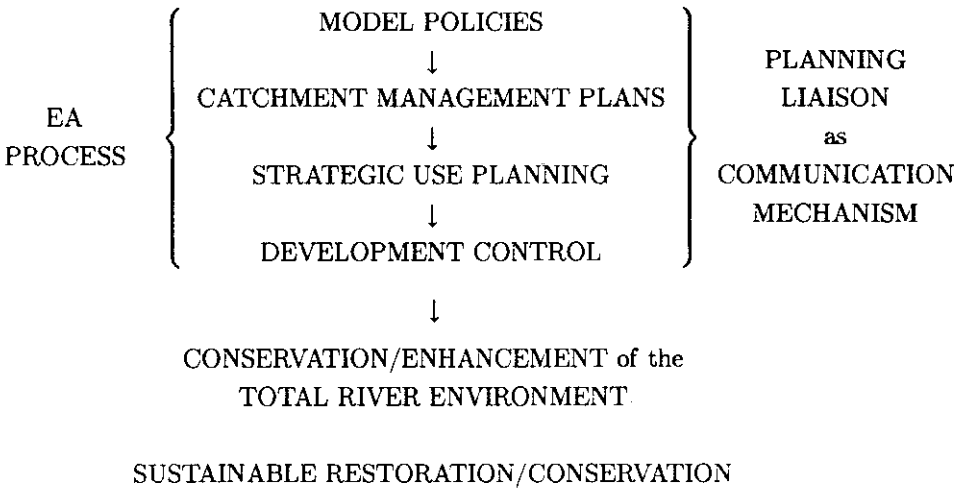

Fig. 1 NRA THAMES REGION PLANNING INITIATIVE

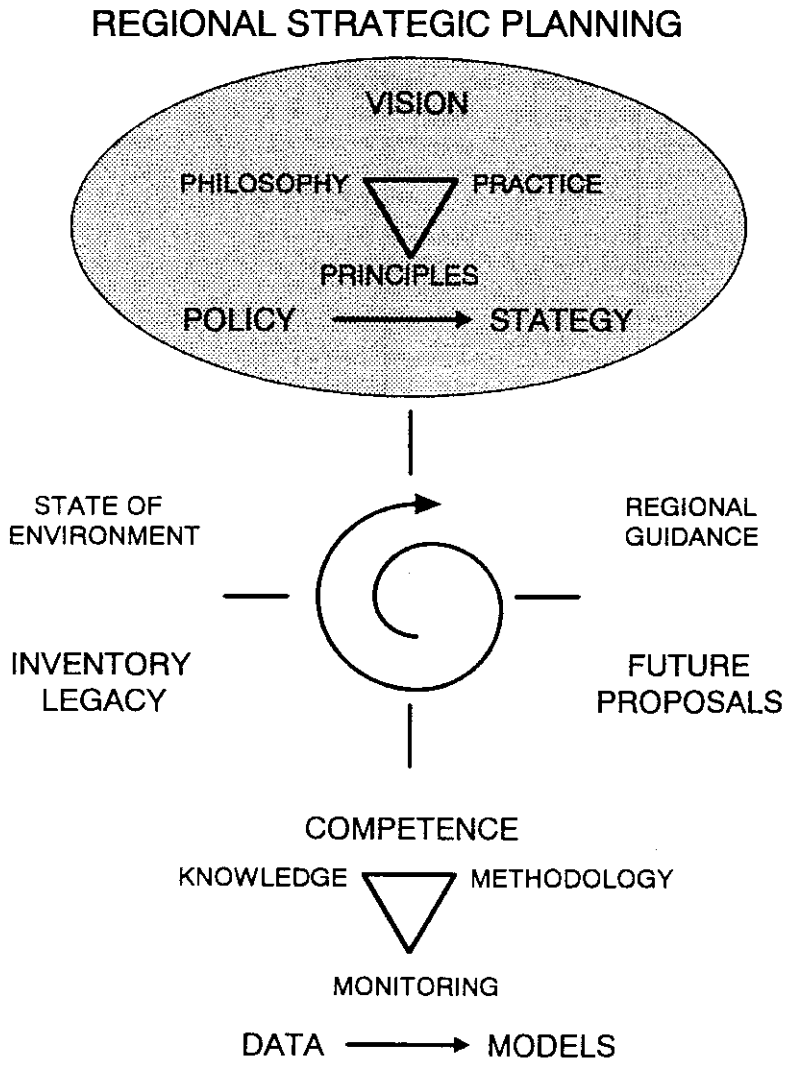

Fig. 2 REGIONAL STRATEGIC PLANNING