WORLD METEOROLOGICAL ORGANIZATION Global Water Partnership

THE ASSOCIATED PROGRAMME ON FLOOD MANAGEMENT

INTEGRATED FLOOD MANAGEMENT

CASE STUDY

USA: *NO ADVERSE IMPACT - A NEW DIRECTION IN FLOODPLAIN MANAGEMENT STRATEGY*

January 2004

Edited by

TECHNICAL SUPPORT UNIT

USA: *NO ADVERSE IMPACT - A NEW DIRECTION IN FLOODPLAIN MANAGEMENT STRATEGY*

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Abstract

Annual flood losses in the United States continue to worsen in spite of 75 years of federal flood control and 30 years of the National Flood Insurance Program. This trend is unnecessary, and is primarily due to federal policies that have encouraged at-risk development, provided for insufficient consideration of the impact of that development on other properties and on future flood and erosion potentials, justified flood control projects based on a benefit-to-cost ratio that favors an intensification of land uses within the floodplain, and engendered an unhealthy reliance on federal resources by state and local governments. The authors propose a new "no adverse impact floodplain" approach that shifts the focus from the techniques and standards used for floodprone development to how adverse impact resulting from those land use changes can be planned for and mitigated. The proposed policy promotes fairness, responsibility, community involvement and planning, sustainable development, and local land use management, while not infringing on private property rights.

INTRODUCTION

Flood losses in the United States continue to escalate. This increase in the level of damage to public and private property, amounts spent on disaster relief, disruption in lives and businesses, and loss of habitat and other water-related resources has occurred in spite of nearly a century of flood control, the implementation of floodplain management standards in about 19,000 communities nationwide, and the mapping of hundreds of thousands of miles of floodplains. Average annual flood losses in the United States are currently estimated at $6 billion. This is a four-fold increase over the past century, or a doubling in terms of dollars of damage per capita in the United States. The general trend is for flood losses to increase every decade.

It is fairly obvious that the policies of governments at all levels, combined with market forces, are leading to more intense uses of floodprone lands throughout the country. Perhaps less obvious is the potential damage brought about when a floodplain is developed or filled so that floodwaters are pushed onto other property, or when the watershed outside the floodplain is developed and the newly increased runoff is allowed to flow freely downhill.

Contrasting these land use realities with economics, the argument can be made that the nation as a whole is better off as a result of these investments in floodprone development that flood losses are simply the price the nation pays for growth. Economic arguments such as this have become a key factor in establishing a federal government interest in flood control. Others have compared flood losses to the gross national product and found no adverse trend. Unfortunately, an alternatives analysis has never been performed to determine if the same level of expenditure and investment outside the floodplain would have led to a better return.

The reality is that when floods hit, people are forced from their homes and businesses, and many never recover financially from the impact. Local, state, and federal officials are faced with rescue operations at great personal risk, there are housing needs for displaced people and immediate expense for the repair of infrastructure; dollars are diverted from necessary public efforts in order to pay for the emergency; and in the end we reposition to wait for the next flood.

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Admittedly, recent focus on and enhanced funding for mitigation is helping to alleviate some of the more obvious problems with existing structures being flooded, but the nation has yet to come to grips with how to stop creating future flood problems caused by new development. The nation's extensive current efforts at flood control and modern floodplain regulation were intended to control flood losses, yet data suggests that losses are not being effectively curtailed.

For many floodplain practitioners this message is neither new nor surprising. Individuals continue to live and invest in a floodplain, with the promise of "flood control," a promise that comes with terms and conditions too often found in the small print. We continue to issue permits for new construction that is marginally protected from today's 1% chance flood (the flood that has a 1% chance of occurring every year sometimes called the 100-year flood) and that may be a foot or more below the level of tomorrow's 1% chance flood. We continue to have extensive debates on how to construct in a floodplain, yet spend little time considering whether that construction itself is in fact making flooding conditions more severe.

It is time to examine whether we have been directing our efforts toward the proper activities in our attempts to minimize flood damage and reduce losses. A proposed new approach to floodplain management, if properly implemented, can protect private property and still allow society to take account of the full suite of benefits provided by floodplains. This new goal, called a "no adverse impact policy", would require those who alter flooding conditions to mitigate the impact their actions have on individuals and adjacent communities. It is essentially a "do no harm" policy that will significantly decrease the creation of new flood damages and promote wise use of floodplains

TRENDS IN FLOOD LOSSES

Flood losses in the United States continue to escalate, although the actual amount is open to some debate. According to the Federal Emergency Management Agency (FEMA), annual flood damage from 1990 to 1998 was $5.2 billion (based on National Oceanic and Atmospheric Administration/National Weather Service data). Hurricane damage was estimated at $5.4 billion annually (based on data from the National Climatic Center) (Federal Emergency Management Agency 2000). In 1992 the Federal Interagency Task Force on Floodplain Management indicated that from 1916 to 1985 flood damage per capita in the United States increased by a factor of 2.5 in constant dollars. (Federal Interagency Task Force on Floodplain Management 1992).

The National Weather Service has some of the best and most up-to-date estimates of flood losses, dating from 1903 to 1999 (National Weather Service 2000). The information is compiled by the National Weather Service, with information from its field offices or other federal agencies. The estimates include direct damage due to flooding that results from rainfall and/or snowmelt. They do not include flooding due to winds (e.g., hurricane storm surges), or coastal flooding. The intensified development in U.S. coastal areas in the latter half of the 20th century can only mean that hurricane flood damage has been exacerbated as well, to be added to estimates given below. Nor do the National Weather Service estimates include loss of business, inability to operate because workers could not get to work, disaster payments, damage to habitat, or other indirect losses. With these limitations in mind, this data set shows the following:

- Average annual flood damage (1999 dollars) for the first half of the 20th century was $2.2 billion, compared to $3.9 billion for the second half of the 20th century.
- Of the top 20 loss years (1999 dollars), 14 occurred between 1950 and 1999.
- Of the lowest 20 loss years (1999 dollars) 15 occurred between 1903 and 1949.
- The five top decades for average annual losses were, in order, the 1990s, 1970s, 1950s, 1980s, and 1930s. It is notable that, with the exception of the 1930s, the top loss decades all occurred in the latter half of the 20th century.

- For the 1990s, average annual losses were $5.6 billion, compared to the 1900-1909 period, when losses were $1.4 billion annually.
- All this leads to the conclusion that a conservative estimate of total flood losses at present at well in excess of $6 billion annually, and that total annual flood losses have increased by more than a factor of four since the early 1900s.

WHY FLOOD LOSSES ARE RISING

There are many reasons why flood losses in the nation are increasing. A simplified view is that there is more at-risk development today than before. It has been suggested that we are having more frequent and more severe flooding due to climatic variation. Others note that, with technological advances, society has less respect for hazardous areas and thus they are being more intensively developed witness the population boom in coastal areas. In other places we may be seeing more damage because we are attempting to rely on levees that are adequate for agriculture, but that fall short of what is needed for high-damage urban settings. These and numerous other technical or societal factors doubtless are contributing to increases in flood losses. We believe, however, that current national policies adversely influence the decisions that underlie many of these situations.

As a nation, we currently utilize investment strategies that in essence encourage intensified uses of floodplain lands in order to justify federal flood control projects. We have fashioned a flood insurance program that allows new development to cause an increase in the level of future floods but ignores that new flood level when establishing rules for where and how high new development must be placed. We have disaster assistance programs that have largely transferred the consequences of intensified land use in floodplains to federal taxpayers or to flood insurance policyholders. We do little to encourage local and state programs for floodplain management or mitigation, thus perpetuating an unhealthy reliance on federal resources.

These three fundamental approaches to reducing flood losses appear instead to be inducing them. Unfortunately, we in the floodplain management community have had more success in defining the methods by which the nation goes ahead and builds in floodplains, and less influence on defining the circumstances in which such building may be appropriate and the conditions that ought to be attached to it.

The flood control mission, the flood insurance mission, and the disaster assistance mission of the federal government all have had positive impact and will remain essential tools for the future. But to minimize the creation of new losses, the nation must rethink its basic approach to floodplain management. Described below are some of the policies that should be revisited.

Flood Control Mission

Many important flood control works have been constructed over the years and there will be a need for flood control in the future. In the past several years we have done a better job of balancing structural flood control with non-structural projects, but the need for improvement remains. A few key factors appear to be influencing flood loss potentials, as described below.

Benefit-cost decision making. Managing floodplains so that they maximize benefit to society is an important objective. An obvious element of this is economic benefit. As a matter of policy, a federal flood control project is considered justified when its benefits exceed its cost. Unfortunately, in too many instances, a positive benefit-cost ratio has come to be interpreted as indicating a wise investment of federal resources. This interpretation has to be called into question when lower-cost solutions to the flood problem are discarded or when one ponders what the return may have been for investing those resources in a less hazardous area. Further, it is apparent that we are struggling with placing a value on natural floodplain functions as we

attempt to measure societal benefits in order to plug them into the cost-benefit balance. The net result is a system that encourages floodplain development either to directly justify the project, or through secondary benefits of the project that encourages floodplain development.

A case in point is the U.S. Army Corps of Engineers practice for calculating flood benefits from a structural flood control project such as a levee or floodwall versus a non-structural project. Per Corps policy "Reduction of flood damage borne by floodplain activities should not be claimed as a benefit of evacuation or relocation because they are already accounted for in the fair market value of floodplain properties." (Empirical Studies of the Effect of Flood Risk on Housing Prices USACE IWR98-PS-2 1998) While this is open for some interpretation, this policy would appear to indicate that flood damage reduction can not be considered a benefit in the case of a relocation, yet in contrast, when a flood control structure was built, flood damage reduction is considered a benefit. The rationale behind this distinction is unclear since the premise appears to be based on the assumption that a flood prone property has a lower market value than one that is out of the floodplain. Once protected or relocated it could be argued that the market value would increase and be equivalent to the market value of non-floodprone property. Yet, if one agrees with the assumption that floodprone market values are depressed, which in and of itself is influenced along regional and socio-economic lines, then for one to agree with the Corps policy it would be necessary to have a view that development in floodplains is the ultimate expression of federal policy.

Induced flood damage. Because of our benefit-cost view of the world, once a structural project is built, there are apparent benefits to developing and intensifying land use within the "protected" zone. Yet to date we have not adequately addressed such issues as higher rates of runoff from developed watersheds or loss of stream storage that will lead to higher flood flows in the future. The net result is more damage from a catastrophic flood, and in all likelihood in a lower level of future protection than provided by the current structural project.

One category of induced flood damage is the extensive filling or encroachment of floodplains that translates into a more rapid movement of flood peaks or stages downstream. When there is natural storage within a watershed, flood stages on the main watercourse tend to attenuate between significant tributaries. Once the natural storage is filled, the stages instead accumulate into higher downstream flood stages. There are techniques that allow an engineer/hydrologist to simulate this impact, but on a single-project basis it is usually considered to be insignificant. On a system-wide basis, however, the impact is highly significant, but in the absence of good regional and basin-wide plans, it has not been practical to consider them. Properly formulated federal flood control projects do consider obvious induced damage, such as increased flood stages resulting from loss of floodplain area. Unfortunately, locally developed flood control projects (private and public) too often will ignore these increases, even though the projects are compliant with the minimal floodplain management criteria established by FEMA. A few communities and some states are recognizing these shortcomings and taking measures to mitigate for these increases (ASFPM 1995), but most do not. Yet it is becoming apparent that these impacts are highly relevant.

Flood Insurance Mission

In recognition of growing flood losses, the National Flood Insurance Program (NFIP) was established in 1968 as a mechanism to provide federal flood insurance for individuals that reside in a community that adopts and abides by certain floodplain management criteria. Since then, the NFIP has done a notable job of bringing floodplain management to most of the nation's communities.
Furthermore, the staff of FEMA, which administers the NFIP, have significantly influenced the role and acceptance of non-structural measures among other federal agencies. However, because the NFIP is viewed primarily as an insurance program, FEMA has been reluctant to

promulgate regulations that account for future flood damage resulting from floodplain encroachment or development-induced runoff. Granted, local and state governments could and should be doing more, but due to lack of information or due to a presumption that a minimum standard set by the federal government is adequate, most communities are not effectively dealing with increasing flood damage.

Construction in floodplains. Since the inception of the NFIP there has been an ongoing debate over whether the program has encouraged floodplain development by providing definable standards and insurance, or whether the program has limited floodplain development while improving how we build in floodplains. While no definitive study on this question has been conducted, there is evidence that could support either argument. Years of interaction with property owners has shown us that flood insurance is not perceived by them as being a benefit. And, until the 1994 revisions to the NFIP mandated reviews of loan portfolios, most lending institutions, if they did bother to see if insurance was originally purchased at the outset of a mortgage, did not bother to see if it was maintained after the initial policy term. At the same time, the construction and land use rules and standards promulgated by localities as a condition of participating in the NFIP have become a cookbook for floodplain encroachment - they breed an air of confidence about how buildings within a floodplain are constructed, yet remain silent about protecting the costly roadway and utility infrastructure required for that very development.

Current floodplain management standards have two essential components. The first is the concept of a two-district floodplain, known as the floodway and the flood fringe. The floodway is the central portion of the floodplain, presumably the area with the greatest water velocities and highest depths, which should be left open in order to avoid increases in flood levels. Under current national standards, however, flood levels can be increased up to 1 foot. The flood fringe comprises the outer areas on both sides of the floodway, and presumably is the area of lower depths and velocities and that stores water during a flood. Current standards allow development in the flood fringe regardless of depth and velocity, and restrict development in the floodway.

The second component is the establishment of the lowest floor of construction at the level of the 1% chance flood. (The discussion in this paper focuses on riverine examples, but there are similar standards for coastal areas.)

When establishing a floodway line, hydraulic engineers consider continuous floodplain encroachments until, on average, the flood levels increase 1 foot. Unfortunately, there is too little consideration given to the residual depths and velocities when the floodway line is established. When setting the floor elevation, the requirements are that the lowest floor of a building be no lower than the mapped 1% chance flood's water surface elevation. In general, no consideration is given to waves or to future increases in the level of the 1% chance flood. The increased future level is usually the result of more runoff from developing watersheds or is induced by floodplain encroachment allowable under the current regulations.

Induced flood damage. Due to the manner in which a floodway line is established, up to a 1-foot increase in flood water depth will result once the entire flood fringe is encroached upon. In many developing areas of the nation, the flood fringe areas are rapidly being filled, but there is no requirement to consider the impact this increase in water surface will have on existing buildings or property. Even worse, when a building is constructed in the floodplain, the lowest floor elevation may be set based upon data that is 15 years old or older and thus could well be below today's true 1% chance flood level. Further worsening this problem is the fact that the floodplain encroachments are displacing land area that the rivers naturally used to store floodwaters. If extensive filling of the floodplain occurs, flood stages are no longer attenuated in the floodplain but instead are passed downstream, further increasing flood levels. Finally, because of development within the watershed, more runoff will flow into the floodplains, but these future flows are not considered when establishing lowest floor elevations.

The net result is that, due to land use actions within and outside the floodplain, existing and future development very likely will experience flood depths of 1 foot or more above the mapped levels, inducing significant new damage. From a broad policy standpoint a 1-foot increase sounds trivial. Consider, however, that the difference in flood depth between a 1% chance (100-year) flood and a 2% chance (50-year) flood is often only 1 or 2 feet. Likewise, the difference between a 1% chance flood and a 10% chance (10-year) flood may only be from 2 to 4 feet. Based on recent evaluations in the Charlotte-Mecklenburg region of North Carolina, planners and engineers are estimating that between improved mapping techniques, accounting for future-conditions runoff from the watershed, and the impact of floodplain encroachment, future 1% chance flood levels will be on average 5.7 feet higher than current mapped elevations. Of the 5.7-foot increase, nearly 4 feet can be attributed to floodway encroachments and watershed development. This becomes important when one notes that a disproportionate amount of damage occurs to a structure in the first foot or two of flooding.

What this means is that today's 1% (100-year) standard, which allows encroachments into the floodplain, in actuality may be tomorrow's 50-year standard, and may only be a 10-year standard once the watershed is fully developed. These trends do not bode well for controlling the escalation of flood damage, and left unchecked could become significantly worse than anticipated by the founders of the flood insurance program. Gilbert F. White has long called for a full-fledged assessment of the effectiveness of the NFIP, and based on these trends, the need for this evaluation is self-evident.

Disaster Assistance Mission

Congress and the citizens of the United States are typically quite compassionate when it comes to assisting those affected by natural disasters. Unfortunately, our need and desire to help those victims has become viewed as a federal responsibility, and only recently has the idea of actually mitigating some of these losses begun to seriously shape disaster recovery programs.

Unhealthy state and local government reliance. The perception among elected officials and, to a lesser degree, professional staff is that when a natural disaster strikes, the federal government will fly to the scene with trucks full of money to solve the problems. In some cases this perception may be true, but in most it is far from the truth. Unfortunately, this perception (coupled with readily available federal flood control projects from the 1950s through the 1970s) has led to a belief that flood mitigation is a federal issue, and is a lesser responsibility of the non-federal entities.
Because of this mindset and competing needs for local funding, most communities do little more than comply with the minimal standards of the NFIP, leading to the creation of increased future flood losses as described above.

Induced flood damage. For many years the sole focus of disaster assistance was rapid recovery with little concern for mitigation. The result was that communities were the recipients of repaired or replacement systems of infrastructure that made floodprone areas attractive locations for development. Only if buildings were substantially damaged (more than 50% damaged in one event) were they rebuilt to be compliant with NFIP standards. The net result is that damage-prone infrastructure was replaced, and buildings that were heavily damaged or destroyed were replaced by buildings only marginally protected by virtue of being elevated to the level established when the flood mapping was done (in most cases many years before the disaster). Only recently (in the 1988 and 1994 amendments to the disaster relief acts) has mitigation become an important element of the recovery process. But it will take years for mitigation to catch up with the backlog of communities that were rebuilt only to be destroyed again.

Summary of the Problem

To visualize how ludicrous the prevailing approach to flood loss reduction in the United States is, imagine a situation in which someone decides to build a house next to a landfill (from most perspectives not a good decision, yet it is within the purview of that citizen to do so). Over a weekend the owners of one property build a home next to the landfill, using government-supported studies that suggest there are no serious problems associated with noise and dust (the study was 20 years old). On Monday, the new homeowners call their favorite politician to complain about the noise and dust from the landfill, at which time publicly funded studies of and projects for sound barriers and dust abatement are approved and get underway. Every Tuesday, more trash comes to the landfill than can fit through the front gate, so the trucks are emptied onto nearby property, including the front yard of the homeowners. The official reason for this overflow dumping is that it was always done this way, no one seemed to care, and no regulations prohibit it. On Wednesday, the trash is cleaned off the private property. On Thursday, the new sound barrier for the homeowners' property and six undeveloped properties is completed, at the same time, town officials amend a master plan that will double the town's population but will not provide any more landfill space. On Friday, six new homes are built on the properties behind the new sound barrier, and everything is wonderful until the following Tuesday, when people come home to find overflow trash dumped in their front yards.

For too long, our national policies have ignored growth-related impact in the floodplain and have allowed construction and paving on the watershed to have "free dumping" prerogatives-increased runoff being "temporarily stored" on downstream properties. At the same time we are taking actions that encourage at-risk behavior. Property owners would not tolerate trash dumped on their lawns, but they do not seem to understand that floodwater "dumped" on their property could easily be avoided.

It is clear that the nation has followed a course that has encouraged at-risk behavior, silently allowed practices that increase flooding potential, and done little to encourage local government innovation-all of which has led to significant increases in flood losses. Trends in flood damage data substantiate that losses are escalating significantly. It also appears that if current practices are left unabated, the potential for a more rapid escalation in losses exists.

To remedy the unintended effects of several decades of flood reduction policies, it will be necessary not only to avoid creating new hazards but also to actively mitigate existing ones. The guiding principle of "no adverse impact" floodplain management described below would significantly assist the nation in meeting this goal.

DESCRIPTION OF NO ADVERSE IMPACT FLOODPLAINS

A "no adverse impact floodplain" is one in which *the action of one property owner or community does not adversely affect the flood risks for other properties or communities as measured by increased flood stages, increased flood velocity, increased flows, or the increased potential for erosion and sedimentation, unless the impact is mitigated as provided for in a community or watershed based plan.* No adverse impact floodplains would become the default management criteria throughout the United States, unless the community has adopted a comprehensive development and management plan that identifies other acceptable levels of impact, and specifies appropriate mitigation measures for those impacts along with a plan for their implementation.

Some might argue that "no adverse impact" as an absolute standard could never be measured nor readily achieved, and those critics may be correct in their observation. However, as a statement of policy "no adverse impact" describes a direction that over time will be supported by standards or plans that lead the nation towards that policy goal. The point of "no adverse

impact" is to get practitioners and policy makers alike to recognize that with limited exception we currently do not consider adverse impacts and that if we are going to control escalating flood losses we must consider how modern practices are influencing this trend.

The principles of the no adverse impact floodplain need to be applied throughout the entire watershed. In too many localities, upstream development in the watershed has induced new and additional damage within the floodplains. Communities need to be encouraged to account for or mitigate that flood damage locally or regionally. This can be done by promoting the use of retention and detention technologies to mitigate increased runoff from urban areas, or by planning for future-conditions flooding within the community and region while mitigating for induced damage. Citizens and professionals alike at times are quick to criticize those that choose to live in floodplains, and in many cases this criticism is justified. Yet it should not be forgotten that the homes, businesses, and infrastructure in other parts of the watershed can be partly to blame for how often and how deeply a floodplain home is inundated.

Although the no adverse impact floodplains initiative will result in improved protection standards for the 1% flood, its true strength is that it virtually ensures that future development activity both in and out of the floodplain will be part of a locally adopted plan. Thus it removes the mentality that flood losses will be eliminated by following the standards “imposed” by FEMA, and promotes local accountability for developing and implementing a comprehensive strategy and plan for development both inside and outside the floodplain. Giving localities the flexibility to adopt comprehensive local management plans, which would be recognized by FEMA and other federal and state programs as the acceptable flood mitigation standards in that community, supports them in taking responsibility for their own flood risk and in their search for innovative approaches to reducing damage.

Some people are concerned that the no adverse impact approach is simply a disguised environmental promotion. This is not the case. The no adverse impact approach was developed to support long-term, sustainable approaches to reducing the nation’s flood losses now and especially in the future. Protection of individual property rights and the management of floodplain for the highest net social benefit must continue to be the central focus of a sustainable flood policy for the nation. Utilizing the natural and beneficial functions of floodplains and watersheds is complementary with a no adverse impact policy. For example, adopting no-rise floodways will lead to more of the natural floodplain being available for other community needs like flood storage, recreation, and water quality filtering thus promoting the wise use of the nations floodplains and watersheds.

Finally, the no adverse impact floodplains approach makes sense and is the right thing to do. Too often discussions on standards become lost in arguing over the range of their application and the impact this or that might have on those who are choosing to encroach onto the floodplain. It is time to manage from the perspective of not inducing additional flood impact on other properties, giving local communities the ability to manage flood losses through comprehensive local plans.

IMPLEMENTING A NO ADVERSE IMPACT STRATEGY

The “no adverse impact floodplains” approach is a different way of viewing flood policy. It moves away from a development standards approach while firmly placing local governments in a responsible position to manage floodplain risks. No adverse impact is a “good neighbor” policy that brings focus to the issue of how existing properties within and adjacent to floodplains are being affected by the land use decisions of others.

In reality the no adverse impact strategy is a collection of initiatives, some of which may be generic and meaningful to all communities and others that are best when tailored to fit the local

situation. These strategies can be both structural and nonstructural, and be implemented by either regulatory or programmatic means.

To be successful, a no adverse impact strategy will require rethinking federal, state, and local policies, and require the involvement of private developers. It must lead to the production and acceptance of locally based comprehensive floodplain and watershed development and management plans. It will require federal and state acceptance of those plans as the standards in a community, as long as agreed-upon goals are met. What this means is that when no local plan exists, all federal and state programs in the floodplain would use standards that achieve no "adverse" changes in hydrology, stream depths, velocities, and sediment transport functions. When a local plan does exist, then impacts will be allowed to the extent that they are provided for and mitigated in the plan.

The local plan would include the management strategies of the locality (or multi-jurisdictional region, if applicable) and appropriate sub-plans that would provide for floodplain-specific tools such as hazard identification, regulations, or specific projects to minimize damage or flood problems. Adverse impact caused by implementation of the plan would be confined to the local or regional planning boundary of the plan. If plan implementation leads to the potential for induced flood damage, then it will be necessary for mitigation actions to be implemented.

Mitigating Adverse Impact

There are various methods of mitigation that could be utilized to offset the impact of development that exceeds local standards. Types of mitigation actions to reduce flood losses include those that modify human occupancy of the floodplain or watershed (usually a nonstructural measure) or modify the flood (usually a structural measure). Examples of implementation include enforcement of regulations and master plans, as well delivery of programs and services. A no adverse impact strategy most likely will contain elements of each.

Table 1 presents the four negative effects that are most likely to result somewhere in the watershed when development activity takes place on floodprone land: increased flood stages, increased velocities, increased flows, and erosion and sedimentation. These are the problems that must be managed, mitigated, or prevented by the locality in order to achieve a no adverse impact floodplain or watershed. The examples are intended to demonstrate some remedial techniques but are not all inclusive. Community approaches need to include development in the entire watershed, since any of this can create new floodprone land.

Table 1. Some adverse impacts of development on floodprone lands, remedy options to mitigate them, and benefits/limitations of those options.

ADVERSE IMPACT	CONTRIBUTING CONDITION	REMEDY	COMMENT
INCREASED FLOOD STAGES		Master plan	Defines the level of allowable impact and necessary mitigation
	Floodplain encroachment	Implement no-rise floodway standard	Effectively used in many states and localities
	Increased flow due to development (increased runoff from development will lead to higher flood stages)	Implement retention/detention standard	Commonly used to maintain existing flow, but must manage volumes and peaks or downstream flooding is increased
		Construct regional storage facilities	Commonly used to maintain existing flow-must also manage volumes and peaks to avoid flood increases
		Map to future-conditions hydrology	Does not address flooding of existing uses in floodplain
		Acquire land or flowage easements	Provides compensation for those impacted downstream
		Increased freeboard for constructed floors	Does not address flooding of existing uses in floodplain
		Channel or levee	Can move problem downstream
INCREASED VELOCITY		Master plan	Defines the level of allowable impact and necessary mitigation
	Floodplain encroachment	Manage velocity at upstream and downstream limits	Places requirement on those encroaching to match predevelopment velocities on adjacent properties
	Increased flow due to development (Increased flows translate into higher velocities)	Implement retention/detention standard	Could be used to maintain pre-existing velocity
		Construct regional storage facilities	Could be used to maintain pre-existing velocity
		Map to future-conditions hydrology	Accepts that there will be increased velocities, provides an opportunity to protect new development. Does not address existing development
		Acquire land or flowage easements	Provides compensation for those impacted by increased velocity
	Channelization and levees	Design so that velocities at upstream and downstream limits are returned to pre-project conditions	The impact to downstream properties is currently ignored in many flood control projects.
		Utilize a restoration and setback levee approach	Provides structural flood protection while reducing adverse impacts to natural floodplain functions

INCREASED FLOWS		Master plan	Defines the level of allowable impact and necessary mitigation
	Increased flow due to development	Implement retention/detention standard	Can immediately address adverse impact on the site of origin. Must also address volumes and peaks to avoid increasing downstream flooding
		Construct regional storage facilities	Can be used to address existing problems. Must also address volumes and peaks to avoid increasing downstream flooding
		Manage to future-conditions hydrology	Accepts that there will be increased flows, provides an opportunity to protect new development. Does not address existing development
	Floodplain encroachment (loss of natural floodplain storage)	Implement no-rise standard	Preserves floodplain storage that may be adversely impacted by future encroachment, naturally attenuates flood flows
EROSION & SEDIMENTATION		Master plan: Master sediment transport analysis and geomorphology study	Defines trends in erosion, the need for in-channel stabilization, and the extent of lateral migration on a system-wide basis
	Channel migration	Setbacks	Avoids inducing additional erosion on other properties
		Bank stabilization	Can lead to instabilities in rest of floodplain although effective in some locations
	Channel downcutting	Grade control structures	Best used in highly impacted streams with significant infrastructure at risk
		Meander restoration	This method slows velocities and can lead to reduced channel downcutting while allowing for natural system restoration.

Increased flood stages. One of the primary problems of managing floodplains and watersheds subject to development, as seen in Table 1, is increased flood stages (or depths). The primary existing control on future flood stages is the NFIP floodway standard, which allows flood depths to be increased up to 1 foot above nature's floodway as a result of floodplain encroachments. The impacts of this 1-foot increase in the flood stage on existing properties and future construction are not considered under the NFIP. The effect of the NFIP's 1-foot-rise standard is that the future condition of the watershed or floodplain is given little or no consideration by states and communities.

To address this lack, some state and local governments require new buildings to be constructed 1-3 feet above the current flood elevation. Others have adopted a modified floodway standard (called the no-rise floodway) that limits the allowed increase in the natural floodway to less than some measurable amount, say 0.1foot. Although freeboard (freeboard is the amount by which the first floor of a structure must be elevated above the regulatory flood height) is an essential strategy for minimizing the potential of flooding to new construction, it does little to address the potential for induced flood damage to existing structures in or near the floodplain.

Other tools that some are using include developing local regulatory floodplain maps premised on a fully developed or irfuture conditionlo watershed condition, utilizing local and regional

basins to store excess runoff such that flood peaks are not increased; or some are exploring the concept of permanent easements that allows future overflow. Each of these techniques lend themselves towards either a regulatory or project based implementation, and are only some of the tools that could be considered.

In recent years a limited number of communities have begun dealing with the issue of not increasing flood elevations caused by floodplain encroachments. The response by the development community has often been to channel the river with concrete to increase velocity, which gets rid of the water more quickly but also leads to the loss of storage in the floodplain. In some cases this has led to the increased severity of downstream flooding.

Increased velocity. Whenever the discharge in a stream is increased without an offsetting increase in cross-sectional flow area, or when the cross-sectional flow area is decreased due to fill or development in the floodplain, velocities will increase. Increased velocity also commonly occurs when levees are installed, pinching in the river. The impact of these actions can be erosion from increased velocity and/or increased flooding or damage downstream. Approaches that limit or result in reduced floodplain encroachment that would increase velocities will prevent this problem. Retention or regional storage options that limit runoff from new development to the amount of discharge that existed before development will also prevent increased velocities. When existing levees are to blame, setting back the levee and restoring natural flow areas to the future condition floodplain of the stream will support a no adverse impact standard. At times, with regional plans, velocity increases may be necessary. However, under a no adverse approach this increase would be identified and mitigated as appropriate in the plan.

Increased flow. A third area of concern is the management of increased flow. These increases are generally the result of paving of watersheds or the loss of in-stream storage due to filling or development. Communities continue to implement and evaluate retention and detention basins so that new development does not increase flow. If properly designed, retention/detention can limit downstream flood damage, and be readily blended into the developed landscape. In some regions retention and detention measures have gained a bad reputation either due to poor design or because they fail due to poor standards. In most cases where these measures fail, the standards appear to be focused on making sure that post-development flows do not exceed pre-development flow rates. However, lacking very specialized design these standards tend to provide insufficient storage volume to actually mitigate the increased flow, especially with larger design floods, or they can truncate and extend peak discharges so that flows may actually increase downstream when basin discharges coincide with other flows downstream. The lesson is that retention and detention can be a powerful tool, as long as it is carefully implemented. In some parts of the country regional storage basins may be a better solution, providing that adequate flow paths exist to convey storm runoff to the basins. In some areas due to steep terrain retention basins are not practical, however by their very nature, channels tend to be somewhat more incised. In these cases alternative strategies such as mapping to future condition flows and mitigating to these levels may be a more practical alternative.

Erosion and sedimentation. Communities often permit development that causes erosion or sedimentation problems at the site of a development or on other property along the stream. Master plans for all development in the watershed may not exist, thus leading to unintended impacts. This is analogous to not providing enough landfill space for new growth. Channelization and bank stabilization designs generally are measured for site-specific performance, but their impacts on channel geomorphology are often overlooked. In some cases this has led to the creation of instabilities, causing channel downcutting and bank erosion. In many cases channels have been “bank protected” with little consideration of how the channel will respond. Often streams and rivers respond with accelerated erosion of other sections of the floodplain to compensate for the loss of sediment supply from the protected reach. Each stream

has a certain sediment need, and if its source is cut off by armoring in one area, it will get it from another portion of the stream.

Sediment transport and sedimentation are perhaps the least-understood functions of a floodplain, yet the consequences of disrupting them can be significant. Some communities are beginning to evaluate the use of erosion hazard setback zones, or they are developing sets of tools for an entire floodplain that can be used to evaluate systematic impacts of all proposed development. However, erosion setbacks while effective, generally do not address some of the systemic issues that influence erosion and lateral migration. In certain cases it may be necessary to control amount of downcutting (degradation of the channel bottom) through structures that are buried in the bottom of a stream used to sustain or to adjust the upstream channel elevation. In many cases channel downcutting is the result of changed hydrology (more frequent runoff), or channels being straightened leading to overall steeper channel slopes. Fluvial geomorphologists have developed techniques that restore channel meander and cross sections that are more appropriate for the soil, land form, and hydrology conditions for the area

Need for a Local Plan

The tendency in floodplain management to date has been to manage part of the impact while ignoring the rest. The net result is that well-intended actions are leading to unmanaged reactions in the system. Even if a community were to implement a piecemeal no adverse impact strategy, using techniques described in this paper, it would realize at best partial solutions and at worst it may cause unanticipated impacts. Therefore, an overall management plan is essential.

A well-done plan would include a technical analysis to quantify current and future conditions; it would incorporate mitigation techniques to minimize impacts; it would identify implementation measures to manage all of the hazard factors identified; it would include strong citizen involvement so the plan is equitable; and it would ultimately provide a vision for future use of the community's land within and outside the floodplain.

The Flood Control District of Maricopa County, Arizona, through its master plan process, is attempting to evaluate these factors. The Agua Fria Watercourse Master Plan in particular is taking a different design tack to this end. The Flood Control District is utilizing multi-disciplinary teams that include engineers, planners, landscape architects, cultural and historical resource specialists, fluvial geomorphologists, and those from other disciplines. In the past, communities have had the engineers define the system, and other disciplines reacted. With the Agua Fria project, the planners and landscape architects define the system, and it is up to the engineers and fluvial specialists to account for impacts as well as the flood function. This requires defining acceptable levels of impact and the needed mitigation measures, it requires the development of new strategies, and it requires a willingness to manage the systemic and cumulative impacts rather than individual impacts.

COMMUNITY CASE EXAMPLES

Three community case examples are given below to show two things. First, there are communities striving to move toward a no adverse impact standard. Second, there are different approaches communities can use to achieve no adverse impact. In each case it is clear that the communities have recognized that development activity anywhere in the watershed can adversely affect properties anywhere else in the watershed, not just in the floodplain. That recognition is the first step for a community. For some communities this recognition will be a shock, they thought they were doing the right thing; others they may have ignored the problems; and others still they may not have cared. Like the results of a "middle-age physical" it is time to recognize that the minimal federal standards is clogging our floodplain "arteries," and that left

unabated we are heading for a flood damage heart attack. Communities need to recognize that their current guidance to development, if it simply reflects minimum national standards or if it only addresses how the new development is built, the net result will be future increases in flood damage to some other property.

The three example communities have varied ways to address development. In one case it is comprehensive regulations, in another it is planning and management, and the third takes a strong approach to identifying the hazard area based on future developed conditions. In truth, each community does some of each, but our intent is to highlight that element which we see as the strongest example that community can provide to other communities in the nation who may want to explore that technique to achieving no adverse impact.

DuPage County, Illinois

DuPage County is a 336-square-mile suburb west of Chicago that contains 40 municipalities. Rapid urbanization is evidenced by a comparison of the U.S. Census figures from 1955 to 1995. The population increased from about 155,000 to 782,000 (a 500% increase), and the percentage of land in agriculture dropped over the same period from 58.5% to 5.3%. Much of the urbanization occurred without consideration of stormwater or floodplain impact. The accuracy of maps of the floodplain was undermined by the impacts of urbanization. Although much of the development was outside the floodplain, it nevertheless had profound impact on the hydrology and hydraulics of the streams in DuPage County. All of these factors contributed to the need for a regional approach to stormwater and floodplain management, which began in 1983 in one watershed.

A major flood in 1987 led to the adoption of a stormwater management plan in 1989, with subsequent ordinances and watershed plans for implementation. The comprehensive and forward- looking nature of the County's plan is reflected in its six objectives:

1. Reduce the existing potential for stormwater damage to public health, safety, life, and property.
2. Control future increases in stormwater damage within DuPage County and in areas of adjacent counties affected by DuPage County drainage.
3. Protect and enhance the quality, quantity, and availability of surface and groundwater resources.
4. Preserve and enhance existing aquatic and riparian environments and encourage restoration of degraded areas.
5. Control sediment and erosion in and from drainageways, developments, and construction sites.
6. Promote equitable, acceptable, and legal measures for stormwater management.

DuPage County activities that move toward no adverse impact. DuPage County is doing many things to reduce the impact of development on other property. The excerpt below shows how the community has achieved a comprehensive interweaving of regulations to accomplish this reduction in impacts.

1. A series of ordinance provisions that require zero impact on others:
   Sufficient detention storage to allow a post-development 100-year release rate of 0.1 cubic feet per second per acre of development.
   Compensatory storage equal to at least 1.5 times the volume of floodplain or depressional storage displaced; and provided at the same incremental flood frequency elevation as the flood storage displaced.
   Wetland mitigation ratios of 1.5:1 for regulatory wetlands and a minimum of 3:1 for critical wetlands.
   Mitigation or avoidance of all wetlands regardless of size.
   Zero increases in floodplain elevations for all developments.

Mitigation for any riparian function impacted by development.
Variances for floodplain standards are not part of the zoning process.
A lowering of flood elevations is required for significant work in the floodway.
One foot of freeboard above the 100-year flood elevations for all new structures even if built outside the floodplain.

2. One-stop permitting for all local permits. This includes not only all local permits, but also includes the Clean Water Act wetland permitting and floodway permitting that has been delegated to the County from the federal and state governments.
3. Use of unsteady state modeling for all DuPage County watershed studies.
4. Numerous capital improvement projects for stormwater runoff improvements.
5. Buyouts of structures in flooded areas, using FEMA acquisition funds and local funds.
6. Floodplain mapping based on future development conditions, so that future development does not increase the runoff or flood elevations. Local funds are also used for maps.
7. A stream maintenance program that encourages volunteer participation in cleanup.
8. A wetlands banking program to insure a no net loss of wetlands.

A review of tax valuation, population growth, and land use indicates that DuPage County's approach has not been a disincentive to economic development in the county. DuPage has an above- average income base, and is considered a technology corridor. Lucent Technologies is based there, as are British Petroleum Research and Argonne Laboratories.

The comprehensiveness of the DuPage County Program is its greatest strength. Because the program sets a minimum countywide standard and has been consistent in regulatory, planning, engineering, and capital components, it has received strong county and municipal support.

Maricopa County, Arizona

The Flood Control District of Maricopa County is a regional authority responsible for the implementation of flood mitigation projects within about 9600 square miles an area larger than several states. Maricopa County is located in central Arizona, and is home to approximately 3 million people. The County experienced a 26% increase in population during the 1990s. By the year 2020 the population is projected to exceed 5 million people. There are 23 incorporated communities within Maricopa County, including Phoenix, Mesa, Scottsdale, Glendale, and Tempe. Central Maricopa County is the junction of several major watersheds that drain most of southern and central Arizona, a portion of Mexico, a portion of New Mexico, and part of northern Arizona. The major watercourse leaving Maricopa County is the Gila River. Major tributaries include the Salt River, the Agua Fria River, and the Hassyampa River, all of which have several other significant tributaries. All of these watercourses are ephemeral primarily because of dam construction and groundwater withdrawal. The primary exception is an area of the Salt and Verde rivers in eastern Maricopa County, which are perennial at this time primarily as a result of releases from dams. Most other watercourses termed "washes," are ephemeral, and are characterized by fast runoff response, high velocities, and potentially high sediment loads.

This community's approach includes strong planning and management elements, which help it move it toward a no adverse impact standard.

The Flood Control District is responsible for the regulation of new development primarily in the unincorporated regions of Maricopa County and at the invitation of the incorporated communities. The District has incorporated several aggressive standards related to floodplain development, although FEMA floodway standards are still observed. Watershed-based regulations include measures to ensure that new development is not subject to flooding by the 1% chance local flood, that flows are being accepted and discharged at "historical" points of concentration, and that retention or detention is incorporated in new development.

In the late 1980s the District championed a uniform retention standard that has been well received by most local communities. The standard calls for the total retention of the 100-year, 2-hour runoff (approximately 2.5 to 3 inches of rain). The explosive growth of Maricopa County makes it apparent that the standard has not hindered the local economy. District hydrologists are now projecting in several watersheds that even with "less than perfect" implementation of the retention standard there will be lower flows in the post-developed condition during the 1% flood. This will have significant positive ramifications on many of the nuisance flooding areas in the community. The standard is doing double duty by being one of the best management practices (BMP) for compliance with the National Pollution Discharge Elimination System.

In spite of explosive growth, significant increases in watershed-based flood damage have not occurred. There do, however, continue to be various hot spots around the metropolitan area. Some flood problems include accommodating runoff in areas where the historical drainage patterns were obliterated long ago by agricultural or older developments, lack of adequate drainage for many of the older roadways, and significant sediment loads in some of the newer developments. These problems can be larger than any individual development and can even be multi-jurisdictional. The District has initiated several efforts to address these kinds of issues.

About 15 years ago the District initiated a watershed-based planning approach called an Area Drainage Master Study. The planning effort is one of the highest priorities for the District and the studies have helped to identify and prioritize regional drainage paths and to identify problems before floods. The District plans to complete all studies in the next 10 years with current priorities being the rapidly growing valleys. With the Area Drainage Master Study program, many of the major watersheds have had hydrology developed, floodplains identified, and critical solutions found. The Area Drainage Master Study solutions, although initially structural in nature, have begun in more recent years to include both structural and nonstructural alternatives. A recent modification to this program is having the plans adopted in regional planning documents, thus becoming "institutionalize" by land use planning agencies.

A second program is the Watercourse Master Plan program. This program is systematically evaluating watercourses for existing flood problems, the potential for the creation of new problems, and most recently the opportunity to include multiple use opportunities within the watercourse. The District obtained authority from the state legislature to develop a specific plan for a watercourse that can exceed the state's standards. The plan is then brought forth to the implementing jurisdictions for adoption. The watercourse master plan includes both structural and nonstructural elements, although lately the District, concerned with long-term capital maintenance, has been emphasizing nonstructural elements. The District also has included fluvial geomorphologic investigations that allow the evaluation of hazardous trends in the vertical and horizontal movement of the river. Erosion hazard setback zones have been included in the master plans. A central component of the setback is that bank stabilization can only be used if the stabilization is part of the master plan, or if adverse impact can be limited to the site on which the stabilization is to occur.

Charlotte-Mecklenburg, North Carolina

This community does a number of things that address the adverse impact of development, but it takes a particularly aggressive approach in determining the future damage and disaster costs prevented in order to justify the added cost of mapping hazard areas based on future development. This element alone provides a quantum leap above the national approach of calculating runoff and basing floodplain maps on existing conditions.

The City of Charlotte and Mecklenburg County area (including six towns) is located in south-central North Carolina. The County is 525 square miles in size and has increased in population by 245,000 in the last 20 years. It is estimated that an additional 300,000 residents will locate in

Charlotte-Mecklenburg over the next 25 years. In the past, traditional stormwater/floodplain management techniques were employed, such as joining the NFIP, using voter-approved bond funds for the protection of property losses due to erosion, and requiring detention on commercial development. Starting in 1994, Charlotte-Mecklenburg initiated a stormwater management program, funded by a stormwater fee, to address infrastructure problems on private property and expand the existing floodplain management program.

In 1995 and 1997, flooding caused $20 million and $60 million in losses, respectively. During this period and as part of the expansion of the floodplain program, Mecklenburg County was in the process of developing the Mecklenburg County Floodplain Management Guidance Document, adopted in late 1997. The Guidance Document has served as a long-term business plan to guide Charlotte-Mecklenburg Storm Water Services in increasing the level of service to the community by meeting the following objectives:

To prevent or reduce the loss of life, disruption of vital services, and damage caused by floods.

To preserve and restore the natural and beneficial functions of the floodplains.

Phase I strategies of the Guidance Document relate to countywide activities that are appropriate everywhere. The Phase II strategy relates to activities that are applied specifically to individual watersheds.

Phase 1 strategies.

I. New development should be managed so flood problems are not increased.
II. The flood warning and response plan should be evaluated to determine its effectiveness to protect people and property during and after a flood.
III. The County's drainage system should be maintained to maximize its ability to carry and store water.
IV. The public should be informed about and involved in floodplain management.
V. Floodplain management agencies and organizations should coordinate their efforts.

Phase 2 strategy.

VI. Flood Hazard Mitigation Plans, based on watershed areas, should be prepared to identify the best mix of floodplain management measures to solve local flooding problems and development concerns.

While all the strategies in the *Guidance Document* are intended to reduce flood losses, Strategies I and VI have the most relevance to a no adverse impact standard.

I. New development should be managed so flood problems are not increased.

Dedication of over $1 million in local funds to re-map the floodplains in Charlotte-Mecklenburg because of the inaccuracy of the FEMA maps. Based on a financial analysis of one of the watersheds, $16 million in structural losses are avoided by investing $250,000 of stormwater fees in improved floodplain mapping. (See discussion below on the County's decision to use future development as the basis for mapping.)

Reduce the amount of developable land in the floodplain and increase the amount of land available for floodwaters. Local floodplain maps and associated regulations require new development to stay outside the 0.1-foot encroachment line.

Mapping and new development should take future development into account. All of the floodplain maps that are being developed assume ultimate development in the watershed upstream. After the base flood elevations are determined assuming ultimate development, an additional 1 foot of freeboard is required (See discussion below on the County's decision to use future-development mapping.)

All of the above regulations were developed and supported by the environmental and development communities and ultimately adopted by numerous governing bodies. These floodplain regulations work in concert with local water quality stream buffer regulations. In a pilot study as part of the floodplain mapping project, it was

determined that setting aside lands for the filtering of pollutants decreased flood heights by 0.5 feet.

VI. Flood Hazard Mitigation Plans, based on watershed areas, should be prepared to identify the best mix of floodplain management measures to solve local flooding problems and development concerns.

To date, four watershed flood mitigation plans have been developed and adopted, involving a significant amount of public participation. In 2001, the plans for these four watersheds, and the remaining watersheds that have not been studied, will be revised or developed based on the new floodplain maps. Each plan cross-references the quality of the surface water in the vicinity as well as the long-term vision for greenways and/or parks.

Based on the public process of developing the watershed mitigation plans, as well as the adoption of the plans themselves, Mecklenburg County has submitted several Hazard Mitigation Grant Program and Flood Mitigation Assistance grant applications. At the present time, Mecklenburg County is managing a $14.4 million buyout project. Significant local funding (35% of the total project costs) has not been viewed as controversial since everyone had input into the process of developing the *Guidance Document* and the watershed-specific mitigation plans.

Using future development conditions in floodplain mapping-How does it save flood damage and community disaster costs? As part of the strategy to determine what impact development in the watershed and the impact filling in the floodplain have on flood heights and flood damage, a pilot study was initiated by Mecklenburg County. The goal is to manage new development so flood problems are not increased. The findings of that study are:

By updating the FEMA map computer models to 2000 land use conditions, flood heights increased 2-3 feet. However, when the ultimate land use in the watershed was loaded into the models, flood height increased another 2-3 feet. Therefore, if the County continues to rely on FEMA for floodplain mapping, the maps will not be keeping up with the impact of development. There is a possibility that new development would be permitted that will ultimately be as much as 2-3 feet below future flood heights.

To determine the relative impact of development in the floodplain, an encroachment analysis was performed looking at the cumulative impact of 1.0-, 0.5-, and 0.1-foot encroachment on flood heights. This is very different from the FEMA mapping standard, which removes flood storage area on a per cross-section basis and does not account for the cumulative impact of floodplain storage area removal in the watershed. A much more informed decision on the appropriate freeboard requirement can be made if a community knows the cumulative impact of filling in the floodplain for specific watersheds.

The largest impact of development in the floodplain is the FEMA minimum standards, which allow a 1.0 foot encroachment. Even though this has a dramatic cumulative impact on flood heights (2.3 feet), it does not exceed the impact of ultimate development in the watershed (4.3 feet).

Therefore, a total prohibition of development in the floodplain was not approved. However, thereis still significant impact when there is development in the floodplain due to storage removal and there has been recent development elevated only to the old FEMA flood elevations. To increase the amount of storage for floodwaters and to provide a stream buffer area for the filtering of pollutants, a local 0.1-foot encroachment line has been mapped as the “open space only” floodway to minimize recent development from flooding in the future.

As it relates to freeboard, the 0.1-foot encroachment analysis, including the water quality buffer, indicated an average 0.2-foot increase in water surface elevations, but there were maximum and minimum differences in the range of 0 to 1 foot. Therefore, the 1-foot freeboard (first floor

must be 1 foot above the regulatory flood elevation) was continued in addition to using new flood protection elevations based on ultimate development in the watershed.

The above policy decisions were made based on increased flood heights, increase in widths of the floodplain/floodway, and additional numbers of houses that are now in the new floodplain as a result of using out-of-date FEMA floodplain maps. It was not until after these decisions were made that a financial analysis was done on the McAlpine Creek watershed that showed investing $250,000 in floodplain mapping prevented $16 million in flood damage. This analysis not only documents the losses avoided due to up-to-date floodplain maps as well as regulating based on future development, but it also provides a baseline for measuring the loss potential in a watershed and the relative impact or improvement from a specific, proposed flood mitigation technique.

Charlotte-Mecklenburg has been expanding its floodplain management program over the last several years and balancing its funding between buyouts and floodplain re-mapping. When the community compared the cost of mapping to buyouts, it was evident that funding future mapping at the local level is a most cost-effective approach for a community.

RECOMMENDATIONS

The authors propose a new policy that is based on the premise of managing floodplains and the watershed so that there is no adverse impact on adjacent properties. “No adverse impact floodplain” is a management principle that is easy to communicate, and from a policy perspective, tough to challenge. A no adverse impact floodplain is one in which the actions of one property owner do not have a negative impact on the flood risk to other properties, as measured by flood stages, flood velocity, flow, and erosion and sedimentation.

The no adverse impact floodplain should be the goal for new national standard for all federal programs that affect floodplains. If adopted, it is envisioned that:

- The no adverse impact floodplain would become the new “default” standard for the vast majority of NFIP communities. As in the past, most local governments will use the standard set by federal programs. But this new standard will go further towards reducing losses and be more flexible as well.
- Individual actions that create adverse impact will be allowed only in communities that have developed and adopted a comprehensive management plan for development inside and outside the floodplain, and only if the adverse impact is confined to the planning area and also mitigated within it. Such a comprehensive plan would specify acceptable levels of impact, combined with appropriate mitigation measures, and a plan for implementation. This puts local communities in charge of their own development.
- The no adverse impact standard would virtually ensure that future development activities in the floodplain and watershed are part of a locally adopted plan. Thus, it removes the mentality that flood losses will be eliminated by following minimum standards imposed by the federal government, and will encourage localities to develop comprehensive strategies that can incorporate various community needs through a range of programs and approaches.
- With the no adverse impact standard, and the accompanying federal recognition of the local comprehensive plan as the acceptable standard in the communities that do have plans, federal resources could be spent on mitigation and other long-term strategies instead of on interpreting standards and defending them in court.
- Because of its flexibility and emphasis on local planning, the no adverse impact floodplain sets the stage for providing incentives that will recognize and reward communities that take strong mitigation actions.

No adverse impact development approaches make sense, and the time is ripe to undertake them. Too often floodplain managers and other professionals have focused on applying management and regulatory standards and debated their effect on the people who are choosing to encroach on the floodplain. It is time to reverse course and adopt the premise that it is not permissible for anyone to impose additional flood impact on other properties. By adhering to this principle we will also be fostering local responsibility and capability for managing floods and floodplain resources.

IMMEDIATE ACTION ITEMS

1. Groups such as the Association of State Floodplain Managers, other professional associations, and state and federal agencies should form partnerships to compile no adverse impact success stories that can be distributed as examples to interested communities and states.
2. State agencies (with federal support as necessary) should begin to assist local governments in the development of no adverse impact strategies.
3. The ability of the U.S. Army Corps of Engineers to assist communities in developing no adverse impact plans and models should be enhanced through programs and resources.
4. The Federal Interagency Task Force on Floodplain Management, chaired by FEMA, should initiate an update of the Congressionally mandated Unified National Program on Floodplain Management. It should focus specifically on flood damage and how a no adverse impact approach would work nationally.
5. FEMA should consider expanding its Cooperative Technical Partner (Community/State) program to include an element of reviewing and adopting locally developed no adverse impact plans. Communities with an approved no adverse impact plan then should perhaps receive more favorable cost shares for disaster assistance programs.
6. Education and outreach must be a significant component of the federal, state, local, and non-governmental organization message. Key constituents that influence floodplain land use need to be identified and then paired with agencies that normally provide technical assistance. For example, the Natural Resources Conservation Service could play a significant role in concert with state conservation agencies in educating Soil and Water Conservation Districts on the importance of a no adverse impact approach.
7. States and the federal government should review and update Executive Orders related to floodplain management to incorporate no adverse impact concepts.
8. Recognizing that it may not be feasible nor immediately desirable for federal or state agencies to rapidly shift to a no adverse impact strategy, it is recommended that incremental steps be taken to test the validity of this approach. This can be accomplished by:
   - Providing technical assistance to develop community-based no adverse impact model strategies. This effort should include ongoing assistance with implementation as well as monitoring and documenting the effectiveness of the approach.
   - Developing cost-sharing guidelines for federal grant programs, (including disaster relief and programs of the Corps of Engineers, NRCS, HUD and EPA) to provide more favorable cost shares for communities and states that adopt a no adverse impact approach.
   - Eliminating direct subsidies of at risk development. Examples include: continuing insurance subsidies for repetitive loss structures and enhanced federal cost shares for disaster relief in communities/states which have done nothing to prevent/mitigate their flood losses.
   - Organizing a task force to review NFIP standards and propose amendments to the Act to bring about more effective standards for community participation in the NFIP.
   - The Community Rating System (CRS) in FEMA provides insurance incentives for community activities which go beyond minimum national standards. Those activities

need to be reviewed with a view toward strongly supporting those which result in No Adverse Impact, and adding such activities if not there now.

9. Currently we lack agreement on what constitutes success in terms of the nation's flood loss management strategies. Further, we lack the essential data that allows us to quantify whether we are successful. There is a need to examine this issue both in terms of what constitutes success and how we measure it.
   - Resources should be allocated to expand the collection of essential data that allows the nation to better track program results.
   - An independent investigation should be done of how to estimate damage avoided by flood mapping to future conditions in several communities. Mecklenburg County, North Carolina, for example, has developed a useful prototype.

CONCLUSION

Current management approaches for reducing flood losses too often allow development to occur without considering its adverse impact on other properties within the watershed or on future flooding potential. This has contributed to steadily rising flood losses and is increasing the potential for future flood damage.

A "no adverse impact floodplains strategy", adopted as a national default standard, would require that consideration be given to the effect that proposed development activity anywhere within a watershed could have on flood stages, velocity, flows, and erosion or sedimentation anywhere within that watershed. It would ensure that future development activity both in and out of the floodplain be part of a locally adopted management plan. It is an approach that will lead to reducing flood losses within the nation while promoting and rewarding strong management, planning, and mitigation actions at the local level.

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