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FROM FALSE SENSE OF SECURITY TO RESIDUAL RISK: COMMUNICATING THE NEED FOR NEW FLOODPLAIN DEVELOPMENT MODELS

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Despite decades of research on floods, flood control, and floodplain management, the tendency is for residents and governments to repeat the past. Development continues in floodplains, rebuilding occurs after events with emphasis on controlling the flood, and upstream and upland development takes place with little consideration of its effects on flooding. Our history with managing floods has centered on flood control which still leaves a residual risk that is usually ignored because of the false sense of security generated by the control measures. Using case studies, this paper argues for a comprehensive approach that is centered on three elements: appropriate risk communication, comprehensive analyses of land use decisions, and attaching responsibility for risky choices at the level where the decision is made.

Key words: flood control, resitual risk, floodplain management, ubban development, land use change

INTRODUCTION

A comprehensive approach to floodplain management centered on careful evaluation of the desirability (or lack of desirability) of floodplain development

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and various adjustment options has been advocated in the United States and elsewhere for decades (White 1945, Smith 1996, EU 2006). Policies have been implemented and changed over time. In the United States, the National Flood Insurance Program (NFIP) has been an important means of promoting floodplain management, but flood control continues to be implemented. In Canada, the Flood Damage Reduction Program, implemented in the 1970s, focused on nonstructural approaches to flood management (deLoe 2000). Yet, in 1999, the federal government backed off this program, making flood damage reduction a responsibility of the provinces, leaving in question the extent to which there will be a return to past practices. Heavy losses from floods in England and Scotland in the past ten years have led to a reconsideration of past practices, which were heavily oriented to flood defences (Werrity 2006). It remains to be seen how these activities will translate into changing policies. Indeed, even though we have more experience with the flood hazard and disasters from which lessons could have been learned, it seems that the old model persists. Structures are rebuilt and repaired in the same location, only limited flood insurance is purchased by those at risk, land uses rarely change to reduce flood impacts, and in many places disaster relief flows from the Federal government.

Creeping incrementalism is the usual mode of operation and getting things "back to normal" following flooding is common. Little account is given to what policy changes might be appropriate that would lead to sound land use practices. Part of this, of course, is due to the inherent inertia of many social institutions that works against drastic changes in our decision-making. Thus, rebuilding is the normal way of responding, even though it is quite possible that the historical reasons for the current location are no longer valid. In the United States, we saw incidences of this following the 1993 Mississippi River floods when many levees were rebuilt, some to higher design levels than before, even while experts were pushing for more comprehensive measures (Interagency Floodplain Management Review Committee 1994). Another example occurred in Yuba County, California, which experienced severe flooding in 1986 and again twice in 1997 following levee breaks (Tobin and Montz 1997). The current plans there include having the levee certified to the 200-year level to allow for development of property that would otherwise be flood-prone, using the argument that the new housing would pay, both directly and indirectly, for maintenance of the levee system for 30,000 other people already living in the flood hazard area (EDAW Flood Control Study Team 2006). The strategy of payment for the levees may be new, but the false sense of security prevails and certainly long-term risk is ignored.

This paper argues that it is time for an honest evaluation of the risk that communities face by employing current development models. Rather than continuing to do the same thing following each flood and expecting a different outcome, it is time to devote resources to communicating risk in such a way that new development models evolve – that we look to do things differently. We know that flood control structures are very effective in protecting against events up to their design levels, and therefore allow development where it would not otherwise be economically feasible. We also know that such protection leads to a false sense of security (White et al. 1958, Tobin 1995), something recognized in many places for many years. A classical example now emerging, of course, follows the devastation caused by the levee failure in New Orleans. The risk to

New Orleans from floodplain development and compromised levees had been described prior to the events of 2005 (Colten 2005) but had been either ignored or not fully understood.

While this false sense of security has led to increased development in areas that are "protected" by flood control structures, there are other examples of a recognized need to look at a holistic flood management process, of which flood control structures are a part (Fleming 2002). Thus, there is now a greater awareness of ongoing threats. Indeed, more recently, the term residual risk has been used to describe the danger that remains even with such protective works (Plate, 2002; Riley, 2007) (Fig. 1). No mitigation measure provides 100 percent protection; there always remains some element of risk. Unfortunately, however, the extent to which that risk is incorporated into urban development decisions, both in and out of the floodplain, is highly questionable. Thus, there are two elements of concern here: 1) how and where development takes place, and 2) how the risk to and caused by that development is communicated.

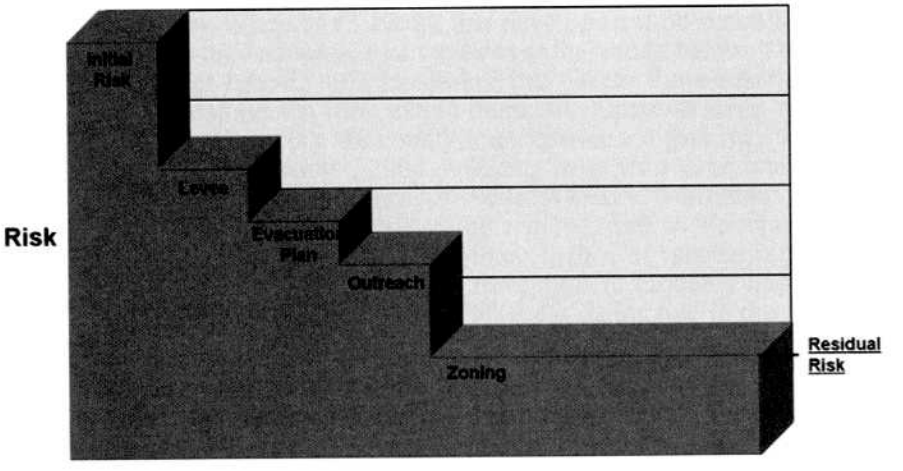

Fig. 1. Residual Risk (Source: Riley 2007)

DEVELOPMENT PATTERNS

It is no secret that development, no matter where it occurs in a watershed, affects flooding (Montz 2000). Whether in the floodplain where it is directly in harm's way, or on higher ground where increased imperviousness leads to increased runoff, development alters the hydrologic regime. Nevertheless, some land uses have in the past benefited from a floodplain location, and it is possible that the benefits of such a location for some activities may still outweigh the costs. However, there are many land uses for which the floodplain location is no longer necessary. Thus, while we do not need to build in floodplains, we continue to do so, for a variety of reasons.

Urban and suburban development patterns, housing costs, and changing demographics have led to increased sprawl, something with which many metropolitan areas around the world are trying to cope. Yuba County, California pro-

vides a useful example (Fig. 2). It is experiencing rapid growth and was the fastest growing county in California in 2006 (Gage and Palmer 2006), due in large part to its proximity to the state capital, Sacramento, and relatively low housing costs in the County. However, much of Yuba County is flood-prone; the floodplain here is wide, flat, and extensive. Historically, the rivers have been constrained by levees to protect farmland and urban development. To accommodate even more urban growth, levees are now being used to make undeveloped farmland "safe" for approximately 12,000 housing units without the worry and potential economic impact of a floodplain designation or the need for flood insurance (EDAW Flood Control Study Team 2006). The levees are designed to protect against the 200-year flood in the belief that this level of protection will prevent disaster. Yet, the history of flooding in Yuba County is one of extreme precipitation events, particularly large winter storms, and of historic watershed alterations. A modification in either of these, the former through climate change and the latter through upstream land use conversions, will have long-term impacts that can alter the effectiveness of any existing flood protection system.

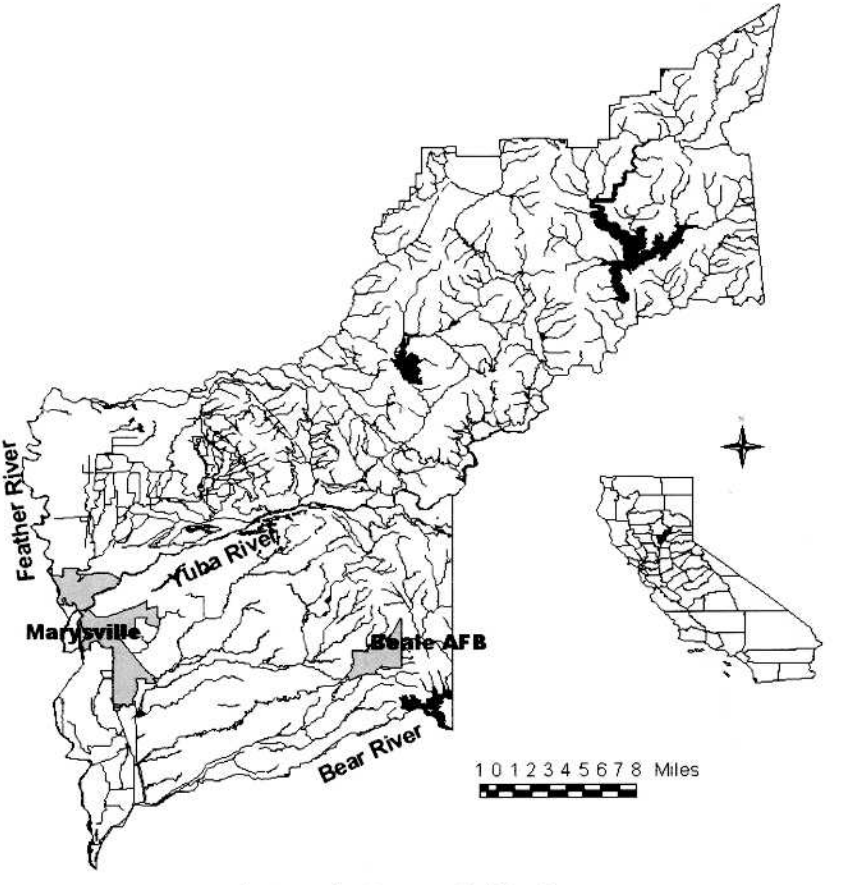

Fig. 2. Yuba County, California

Yuba County is not an unusual example in this regard. Officials there are responding to a number of needs and demands, especially for affordable housing. In so doing, however, they are developing a sprawling urban pattern that follows classical past development models. The end result is eventually one of disaster and devastation to the community. The residual risk is not being managed effectively by politicians and decision-makers, nor is the risk being communicated successfully to residents.

This pattern is being repeated across the United States. Sprawling, low-density development is occurring even in counties which are losing population, and flood regimes are being altered as a result. Even though demand for new homes has declined in recent years, it had been strong for more than a decade. One report about Maryland in 2002 said that the only thing holding it back was the availability of land (Reed 2002). Similarly, Broome County, New York (Fig. 3), which experienced a decline in population from 212,000 to 200,500 between 1990 and 2000, saw 2,000 more single family units at the end of this period than at the beginning. Because much of the floodplain is already fully built (documented by White et al. 1958), this development occurred on the hillsides and hilltops to take advantage of views over the valley below. This has led to increases in water runoff, thus increasing the risk to those residing on the floodplain and downslope. To what extent these developments have contributed to recent events is unclear, but the county has experienced four major floods in a 26 month period: in September, 2004, resulting from Hurricane Ivan; in April 2005, from a snow-melt event; in June, 2006, from heavy, continuous rain (now the largest flood on record for much of the region); and in November, 2006, from overland flow created by more than three inches of rain falling in a few hour period (Montz et al. 2007). The new development probably had little impact on the first two events, but may have played a major role in the latter two, particularly the November event. Of course, the development reviews for these building permits did not take into account the cumulative impacts on flood flows.

The Broome County and Yuba County examples are illustrative of the development pressures that can occur from increasing population or from changing demographic characteristics and human preferences. The two, though, are hardly unique, but rather are representative of the changing risks that are being created by local decisions made everyday. Certainly, development will occur, if only because of the economic benefits, both actual and perceived, from putting the land to a higher use. Yet, this development frequently comes with risks, in this case the danger of flooding, that is often not recognized and does not enter into decision-making, particularly when such development occurs in a non-designated floodplain or outside the floodplain. In all fairness, it is important to note that quantifying these increases is a very difficult task, varying with size of catchment, storm return period, and mitigation measures, to name a few (Wheater 2006). Therefore, the complexities associated with this are many. At the same time, too frequently those who profit from the development have little stake in the risks; they are focused more on short-term gains (National Research Council 2006). In the Yuba County case, it is the residual risk that exists because the levee will not protect against all floods. In Broome County, it is the increased risk of flooding to those downhill and/or downstream. At issue, there-

fore, is how to communicate these very real, yet frequently unquantified risks so that communities, decision-makers, and individuals understand the need for a new development model that takes into account the risks as a cost of this development.

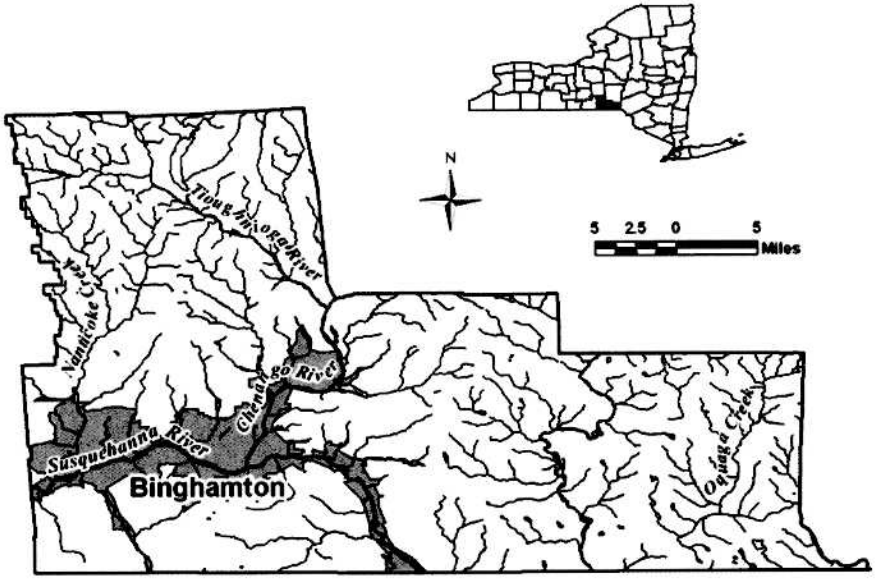

Fig. 3. Broome County, New York

COMMUNICATING RISK

Communicating flood risk has been shown to be quite difficult, given the lack of understanding the public and even officials have of common terminology such as risk and particularly of the 100-year flood (Covello et al. 1989, Hance et al. 1989, Bell and Tobin 2007). Similarly, the causes of flooding are often assigned to rivers and streams and not to the encroachment of urban structures onto the floodplain or to the impact that changed land use has on the hydrologic system. For example, while the Flood Insurance Rate Maps (FIRMs) associated with the NFIP in the United States provide one way of depicting risk, they are too frequently misunderstood as predictive maps rather than simply tools for administrative guidance. In addition, faith in their accuracy can often be a mistake. Initiatives by the Federal Emergency Management Agency (FEMA) to modernize, update, and increase the accuracy of FIRMs will likely address some of these problems, but many concerns will remain. Indeed, these difficulties are inherent to any mapping exercise where the situation is seen as static, which, of course, is not usually the case for flooding and urban areas. Incorporating the dynamic nature of flood risk is a very difficult undertaking and will likely result in similar misunderstanding and perhaps greater confusion, leading to demands for more flood protection or alteration of rivers and streams. Nevertheless, it is the dynamic and ever evolving nature of the situation that is important.

As stated above, residual risk remains even after flood protection structures are in place or stream modification has been completed. Further development in and outside the floodplain can increase risk and/or lead to changes in the nature of that risk. Without some means of communicating this in a manner relevant to all affected, those at risk will live with a false sense of security. This is shown by the plans in Yuba County. Until the 200-year levee is completed, developers of the housing in the floodplain have agreed to carry out a flood awareness program and to cover the costs of flood insurance. Once the levee is in place and certified, both of these programs will stop. What message does that give the residents? Similarly, in Broome County, development out of the floodplain is approved with little or no consideration given to the impacts on flooding, no matter how large the proposed development. Stormwater requirements of the Environmental Protection Agency are followed, but these are designed to reduce pollution, even though they also have some impact on local flood flows. These requirements do not address the impact of hydrological changes on communities downstream. For instance, what about increased overland flow under extreme conditions? These are not part of the decision-making process, illustrating that local officials either do not recognize the dynamic nature of the flood risk or are unconcerned about it, given the usually small scale and incremental nature of development. Indeed, the majority of letters to the editor in a local Broome County newspaper regarding the 2006 floods call for flood walls, stream clearing, and river dredging rather than comprehensive planning (Montz et al. 2007). The cumulative impact of all changes in the watershed is either not recognized or is ignored.

These examples are not uncommon, suggesting that different ways of communicating the risk need to be considered. This is a difficult enough task as floods are impending, and the National Weather Service has been looking at how different messages and different technologies can be used to get people to take action (see National Research Council 2006 and Ryan 2003 for examples). As the time frame increases, so do the difficulties in communicating the magnitude and significance of the risk. Lessons can be taken from work on communicating risks associated with climate change (Moser and Dilling 2007), but we still have a lot to learn about how such information can be disseminated most effectively (National Research Council 2006). Certainly, the focus needs to be on local and regional scales that take into account local and regional trends, needs, and priorities.

On one hand, flood risk is very complex, resulting not just from hydrologic and land use characteristics of the watershed but also from the history of flooding and flood management. Context is important, as shown in comparisons of approaches to flood management by different countries (Pottier et al. 2005) and by various levels of government. Financial, technical, and regulatory factors, combined with past and current development trends and priorities, all affect flood risk. On the other hand, even as the complexity has increased, so has the technology available to address this complexity. With increases in technology have come new tools to facilitate research and understanding of both the elements (hydrologic, physical, and anthropogenic) contributing to the risk and their relative contributions, thus broadening the range of potential mitigation strategies and their application to specific problems in specific locations (Tobin

and Montz 2004). Geographical information systems (GIS), remote sensing, and satellite imagery have been combined with complex models to allow for comprehensive evaluation of the dynamics of watersheds.

Given the above, it is clear that we now have tools that can be applied to both understanding and communicating risk. Yet, communication is only effective if those who are the recipients of the information understand it and act on it. Effort has been devoted in recent years to bridging the gap between physical and social scientists with respect to developing and presenting information about risk and uncertainty, but much remains to be learned (Gerber and Neely 2005). Specifically, how to bridge the gap between scientific estimates with the uncertainty associated with them and the values and needs of various stakeholders remains a particularly difficult hurdle (Downton et al. 2006). Still, having some information is preferable to not having any. As a result, every effort must be given to communicating the risk that exists in an area, in a comprehensive framework. The devastation from Hurricane Katrina came as too much of a surprise to too many, despite knowledge by physical and social scientists about the risk. The emphasis, therefore, must be on communicating risk, particularly when uncertainty plays such a prominent role, and it is imperative that we continue to pursue this in both basic and applied research, with at least some emphasis on translating the findings to be useful at the local level.

CONCLUSIONS AND RECOMMENDATIONS

In the United States, land use development is a local responsibility, but the impacts of development decisions are frequently felt more broadly, particularly downhill and downstream when it comes to flooding. Because of the magnitude of flood losses and the costs of many adjustments, mitigation has historically been undertaken at higher levels of government. Such an approach, while understandable from humanitarian and technical perspectives, has allowed local decision-makers to avoid taking a comprehensive look at local and regional flood risk and their contributions to it. The NFIP is one means of shifting some of the responsibility to local areas, but the Broome County and Yuba County examples (as well as other research) suggest that this program has not been fully and effectively utilized. The "surprises" that flood events still bring and the demands for Federal assistance afterward suggest that something has to change. Flood risk is increasing, a result of some combination of climatological, hydrological, and anthropogenic factors, at the same time that pressure for federal dollars is growing. It seems apparent that current trends cannot continue, but concentrated efforts on the part of policy-makers are required to bring about any changes. Change is essential and this requires the willingness of policy-makers and politicians at all levels of government, something that is challenging given the range of factors contributing to flood risk.

The first step is developing models that depict current and potential flood risk for local areas. In the United States, FIRMs, particularly modernized and updated FIRMs, can do this. However, as communities plan to respond to a flood event or to prevent the next one, models that incorporate various elements of a flood mitigation strategy need to be utilized. Obviously resources will have to be devoted to data collection and model dissemination and adaptation, but the

investment can be justified rather easily, particularly if it is subsidized by state and federal sources. Yet, having the information is not sufficient – using it to help frame decisions is critical, while also recognizing the needs, goals, and values of the range of stakeholders. Risk communication strategies need to be developed, which will also involve resources for research, testing, and dissemination.

The steps outlined here will require money and personnel, as well as assistance with critical and ongoing data collection. However, the investment can be justified if it reduces future flood losses, just as other investments in both structural and nonstructural measures have been justified in the past. The situation is changing, given population growth trends, land use development priorities, deteriorating infrastructure, and budgetary constraints to prepare for and respond to disasters. Thus, our drainage basin practices have to change, not by discarding what has been done in the past, but rather by taking a more comprehensive local/regional view of flood mitigation, because repeating the past in mitigation repeats the disaster past as well. The ultimate goal of the steps advocated here is development models that lead to comprehensive approaches of flood management. In turn, it is anticipated that these will lead to economic uses of floodplains that cause communities to recognize their residual risk as well as the costs and benefits of their development choices. In this way, perhaps, we can overcome the tendency to underrate the risk, which generates a false sense of security, through more effective communication. With more effective communication and a better understanding of risk, it is much easier to understand the personal responsibility for the risk that one takes, whether as an individual or as a community. The costs and benefits of floodplain development can then be more appropriately distributed.

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NESPRÁVNE CHÁPANIE ZABEZPEČENOSTI A REZIDUÁLNE POVODŇOVÉ RIZIKO: POTRBA NOVÝCH ROZVOJOVÝCH MODELOV PRE ÚZEMIA NÍV

Napriek desaťročiam výskumu v oblasti povodní, povodňovej ochrany a hospodárenia na záplavových územiach, ako aj skúsenostiam s povodňovými katastrofami, z ktorých by sme sa mohli poučiť, sa zdá, že staré prístupy k ochrane pred povodňami pretrvávajú. Vieme, že výstavba vodných nádrží, ochranných hrádzí a úpravy korýt sú efektívne opatrenia, ale len do chvíle, pokiaľ povodeň nedosiahne úroveň návrhových hodnôt maximálnych prietokov, na ktoré sú vodohospodárske stavby dimenzované. Takáto ochrana vedie k falošnej zabezpečenosti pred povodňami a k reziduálnemu povodňovému riziku, ktoré zostáva po vybudovaní takýchto stavieb.

V príspevku sa poukazuje na to, že nadišiel čas na uplatnenie pravdivého hodnotenia povodňového rizika, ktorému sú obce a mestá v súvislosti s ich rozvojom vystavené. Na príklade rozvoja dvoch okresov v USA (Yuba County v štáte Kalifornia a Broome County v štáte New York) sa analyzuje: a) povodňové riziko vyplývajúce z rozdielnej priestorovej konfigurácie rozvoja, b) spôsob oznámenia (kumunikácie) povodňového rizika vyplývajúceho z tohto rozvoja. V prípade Yuba County v snahe vyhovieť požiadavkám na cenovo prístupne bývanie sa vystavalo 12 000 bytových jednotiek, na širokej a povodňovou ohrozovanej nive. Ochrana bytových jednotiek pred povodňou sa zabezpečila vybudovaním ochranných hrádzí dimenzovaných na hodnoty návrhových maximálnych prietokov s priemernou dobou opakovania 200 rokov. Účinnosť takejto protipovodňovej ochrany však môže byť zmenená jednak v dôsledku klimatických zmien, ako aj zmien vo využívaní zeme v povodiach riek okresu Yuba County. V Broome County bol taktiež tlak na výstavbu nových bytových jednotiek avšak v dôsledku toho, že lokality na nivách boli už zastavané, bytové jednotky sa začali stavať na svahoch a plošinách vrchov s výhľadmi na údolie pod nimi. Takáto zástavba však viedla k zvýšeniu povrchového odtoku a k zvýšeniu povodňového rizika obytných jednotiek lokalizovaných na úpätí svahov a nive.

Obidva príklady ilustrujú vznik povodňového rizika v dôsledku rozvojových tlakov. V prvom prípade je to reziduálne povodňové riziko, pretože ochranné hrádze neposkytujú absolútnu, 100 % ochranu pred povodňami a v druhom prípade sa zvýšilo povodňové riziko sídiel na úbočí svahov a ich dolných častiach. V prvom prípade boli síce navrhnuté určité opatrenia na zmiernenie vzniknutých povodňových rizík, ale po výstavbe ochranných hrádzí sa upustilo od ich realizácie a v druhom prípade sa o nich vôbec neuvažovalo. Informovanie obcí, riadiacich pracovníkov a jednotlivcov o týchto veľmi reálnych, aj keď často nekvantifikovaných rizikách je veľmi dôležité preto, aby pochopili, že nový rozvojový model zahŕňa v sebe riziká, ktoré sú cenou za tento rozvoj.

Komunikácia o povodňovom riziku sa však ukazuje ako zložitý problém. Verejnosť ani predstavitelia obcí často správne nechápu význam základných termínov, akými sú napr. povodňové riziko a 100-ročný maximálny prietok. Podobne aj príčiny vzniku povodní sa často pripisujú samotným riekam, a nie rozširovaniu zástavby na zaplavovaných územiach a zmenám v hydrologickom režime v dôsledku zmien vo využívaní zeme. Taktiež mapy povodňového rizika sú často chápané chybne ako predpovedné mapy, a nie ako administratívny informačný nástroj a navyše mylná je aj viera v ich presnosť. Súčasné technologické a softvérové nástroje (DMR, satelitné snímky, GIS) umožňujú pomerne presne zachytiť a vizualizovať rôzne zmeny v povodiach a poukázať tak na dynamický aspekt povodňového rizika. Komunikácia je efektívna len vtedy, ak tí, ktorí sú prijímateľmi informácií o povodňovom riziku, túto informáciu pochopia a na jej základe začnú konať. V tejto súvislosti sa vedie medzi prírodovedne a spoločenskovedne orientovanými odborníkmi diskusia ohľadne prezentácie informácií o povodňovom riziku a neistôt spojených s jeho určením. Výsledkom tejto diskusie by mal byť spôsob, ako vedecké poznatky o povodňovom riziku pretransformovať do podoby, aby boli použiteľné na lokálnej úrovni.

Vzhľadom na to, že povodne spôsobujú rozsiahle škody, historicky sa zaužívala prax, že výdavky na úhradu škôd sú hradené z federálnych zdrojov. Tento prístup, aj keď je z hľadiska humanitárneho a technického pochopiteľný, však umožňuje riadiacim orgánom na lokálnej úrovni, aby sa vyhli komplexnému hodnoteniu povodňového rizika na lokálnej a regionálnej úrovni a svojej zodpovednosti zaň. Je zrejmé, že v dôsledku rastúcich tlakov na federálny rozpočet tento trend pokračovať nemôže a je nevyhnuté pristúpiť k určitým zmenám na všetkých úrovniach riadenia štátu, čo sa týka zodpovednosti za faktory podmieňujúce vznik povodňového rizika.

Preložil Ľ. Solín