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SOCIO-ECONOMIC IMPACTS AND CONSEQUENCES OF EXTREME FLOODS

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Abstract. While floods have been the constant companion of humanity, recent catastrophic inundations all over the planet have raised new questions as to traditional approaches in understanding and in responding to such extreme hydrologic events. Looking back, many societies have accepted floods as the inevitable vagaries of nature or acts of God to be endured. In modern times, however, the interaction between water and society has produced a changing attitude as control over the physical environment has increased and technology and social organization have made possible successful manipulation of natural resources. Population expansion, rapid urbanization, the increasing occupation of floodplains, and competing and conflicting developmental demands have exacerbated the impacts of floods on society and the environment. The paper deals with the notion that floods as a "sociological" phenomenon extend beyond hydrological conditions, to encompass consequences on the well-being of human communities. Furthermore, potential climatic shifts, large scale dislocations, socio-economic changes and national and international events have coalesced into the creation of large scale apprehensions and have focused attention to the need for more integrated, anticipatory and far-reaching water policies and strategies. In both the popular mind as well as in significant parts of the professional literature, there seems to be an increasing recognition that even the former relative stability of climate tends to disappear. Indeed, weather oscillations have increased the concern as to present and future impacts of long-term climatic changes on the surrounding environment. Such views tend to reinforce a free-floating apprehension as to human vulnerability and concerns towards an environment that can be further mismanaged or abused. The findings that periods of gentle climates between ice ages are becoming much shorter than had ever been thought before have reinforced the preoccupation with the doom and gloom of rapid changes and the proximity of potential catastrophes. Short-term weather vagaries and simplistic meteorological interpretations get confused with more sober analysis, while prophets of gloom compete for attention as colorful doomsday scenarios unfold in the popular press.

1. INTRODUCTION

Recent catastrophic floods all over the globe have raised new questions as to traditional approaches in dealing with such extreme events. Many societies have accepted floods as inevitable natural phenomena to be endured. However, in modern times, a changing attitude has emerged as control over the physical environment has increased and technology and social

organization have made it possible successful manipulation of natural resources. The increasing occupation of floodplains, and competing and conflicting developmental demands have exacerbated the impacts of floods on society and the environment. Furthermore, the concerns of human vulnerability and an environment that can be further mismanaged or abused, have focused attention to the need for more integrated, anticipatory, and far-reaching water policies and strategies.

The outline of the overall argument of this paper is presented in Table 1 (Attachment 1 shown at the end of the paper). It revolves around three broad categories of concern, i.e., the long history of the entwining between floods and society; the gamut of flood impacts and consequences, and the difficulty of responding to catastrophic floods in an increasingly complex and fast-changing socioeconomic context. Underlying the outlined argumentation is the notion that floods as a "sociological" phenomenon extend beyond hydrological conditions, to encompass consequences on the well-being of human communities. The last underscores a number of important concerns, including:

a) changing social environments because of urbanization, sprawl, increasing densities, or industrialization which in turn may affect vulnerability to floods of larger segments of population;
b) responses to flood which are becoming more complex as more interdependent systems are affected and the calls for more integrated, long-range planning are increasing; and,
c) responses to flood which require also broader mobilization of institutions and people in order to accommodate adaptive policies for resource scarcities, climatic vagaries, and the uncertainty of future environments.

A requisite broader ecological frame of reference implies two major elements that relate human activities to the environment, namely, interaction and adaptation. Ecology, to start with, reflects not only how human utilization of nature influences and is influenced by social organization and cultural values (the interrelationships between population, culturally styled needs and wants, technology and methods of production and the ways of dividing natural resources); but also how adaptive behavior or coping mechanisms and ways of dealing with people and resources are developed in order to attain goals and solve problems. Thus, in this mutually reinforcing relationship between nature and society as mediated by culture, the key problem of adaptive behavior revolves around the question of how people respond to severe constraints and to periodic catastrophes. The literature of human ecology is rich in inference as to how populations and their culture exist in a reciprocal relationship with the surrounding environment. The key to survival that appears in the literature is the capacity for adaptation. Historians and other social scientists have pointed out that such cultural traits as flexibility, reserves, and mobility are the most important, indispensable, and inevitable values in the cultural pattern of many regions.

The present abbreviated paper proceeds, then, in discussing the three parts outlined in Attachment 1. Briefly, the key points to be emphasized follows.

2. THE CHALLENGE OF FLOODS

Underlying the discussion in this section is the notion that floods and droughts as extreme hydrological events have strong similarities in the form of both chronic and periodic hazards and

disasters (Attachment 2). The subsequent discussion emphasizes how flooding is the most common of all environmental hazards. The reason lies in the widespread geographical distribution of river valleys and low-lying coasts with their obvious attraction for human settlement. At the same time, flood-intensifying conditions such as urbanization and deforestation increase the magnitude, frequency, and intensity of floods. Floods, like most other disasters, have certain features in common: losses are rising, catastrophe potential is enlarging, and the burden of loss and adjustment costs falls inequitably among people and regions. Thus a series of interlocking crises (Attachment 3) lead to an escalation of ecological perturbations and to what one may describe as the process of "*complexification*."

The Old Testament account of the Deluge represents starkly the apocalyptic natural cataclysm and is part of long historical flood legends. The profusion of legends testifies to the myriad of floods that have afflicted humanity. These are not mythical accounts but real events inspiring fear and insecurity as to the surrounding environment. The brief historical discussion attempts to relate the pivotal force that has characterized human development. More, it links old *megadisaster* fears with such current doomsday feelings as global climatic change, the drastic alteration of the water regime, and the increased demand for flood control, storm protection, or catastrophic surges.

The expanding concerns with environmental stress tend to reinforce prevailing fears that something fundamental is changing in the relationship between individuals and nature. As a matter of fact, a number of scientists believe that the world strains today are signals of fundamental and perhaps unsolvable crises: namely, the approach of physical limits to human and material growth. This argument is accentuated by increased awareness as to what the human presence is doing into the surrounding ecosystem and to the natural laws concerning young and mature ecosystems. The key question asked has to do with the tolerance, resiliency, or recoverability of the surrounding environment and reflect a concern with the assimilative capacity of the environment to absorb human intervention or to meet increasing demands. These last remarks are particularly important when one considers the rapid social changes, globalization and interdependence that characterize recent societal transformations. These forces increase the complexification of surrounding physical and social systems, intensifying the severity and duration of flood impacts and consequences. Modern society, because of its size, complexity, vulnerability, diversity, environmental alterations, etc., contains a comparatively high degree of potential disorganization. They are all expressions of larger stresses and strains resulting not only from physical hazards; but also from such interdependent transformations as population changes, spatial imbalances, the rapid pace of technological changes and of significant environmental deterioration.

A central concept is that of "*vulnerability*" to floods. In the simplest form, the exposure to risk and the level of reaction to natural hazards vary greatly from community to community and from nation to nation. The discussion here centers around the question as to what extent the catastrophic floods are "*acts of nature*" or "*acts of man*." A theme that has appeared especially with the catastrophic 1993 Mississippi floods and throughout Europe in 1995 is that hydrologists and water engineers have to rethink the way they manage rivers, in the face of worldwide accusations that they have only increased flood risks. The Dutch Environment Ministry has referred to the "*river architects*" as those responsible for ill-advised efforts *to contain rivers in straightjackets*. The urgent call (coupled with apprehension about climate changes) is for drastic solutions (Attachments 4 and 5). This has been also graphically illustrated in the case of the Mississippi floods (Attachment 6).

Turning attention to social conflicts and floods, five crises are outlined (Attachment 7). These crises provide the basis for three basic areas of conflict and disagreement (Attachment 8): cognitive conflicts or disagreements about facts and "critical variables;" stakeholder conflicts reflecting coalitions of social power, or "parties-at-interest;" and, ideological conflicts or value preferences, alternative visions, or postures towards the future.

The last section of this part concentrates on the long attraction of humans to floodplains. The social and economic benefits of inhabiting and using floodplains, despite the negative effects of periodic floods, have made attractive the cohabitation with such a risk. This affinity for floodplain occupancy serves as a backdrop for understanding the dilemma between noticeable production and settlement advantages, and the disastrous human and economic costs that follow overflow of rivers. This is the context within which the Floodplain Management Report (1992) must be discussed. Its analytical approach, the richness of detail, the many options and alternatives are also colored by a certain caution as to the larger question of integrated land-use planning and land-use controls.

3. THE GAMUT OF FLOOD IMPACTS AND CONSEQUENCES

The centrality and importance of flood perception is reinforced by other studies of natural hazards and risk perception. Researchers have already hypothesized that heightened hazard perception could be expected where the hazard is directly related to the resource use. Psychologists and behavioral scientists have also pointed out the socio-psychological consequences of differential perceptions. Similarly, geographers have pointed out how variations in perception of natural hazards depend on dominant use, frequency of natural events, and personal experiences. Other recent findings from the disaster literature point out that public perception of risk is a multi-dimensional concept or a social process rather than a single variable. Perception is also related to the communication of risk. Public risk information and communication help the public perceive both short- and long-term consequences. Risk communication (and the related concept of "warning") have been linked with the users' environment (physical and social cues); social attributes (e.g., social network, economic resources, and demographic characteristics); and psychological attributes (such as knowledge and experience with risk). Together with perception one must also consider the long-term societal repercussions from catastrophic floods, the sapping of the human spirit, the visible scars, and the various economic costs.

The search for typologies is not only an academic exercise in conceptual clarity. It becomes the backdrop for a systematic examination of impacts, the long-term consequences, and the studying of intangible losses. When combined with a variety of damage factors (e.g., frequency, magnitude, seasonality, duration, density of occupancy, etc.) typologies of impacts can provide the consideration of important matrices leading to meaningful implementation strategies for coping with and adjusting to floods.

The discussion around the topic of expanded spatial extent points out how the spread of people over larger areas, *metropolitanization*, and the complexity of modern life have produced new disaster modalities. Such modalities are a combination of changes in predictability, sources of stress, and perceptions of solvability. The extension of temporal and spatial boundaries when coupled with changing attitudes towards nature (e.g., search for ecosystemic integrity) provides for new hazards dialectics and perception of flood impacts. In other words, transboundary

interdependencies, global awareness, uncertainty, and socio-political cleavages strengthen attitudes of *catastrophism* and calls for more coordinated action.

4. RESPONDING AND ADJUSTING TO FLOODS

The overall emphasis on increasing complexity and the need to cope is based on a perceived grand transformation result of cross-cutting forces of complexity and turbulence (Attachment 9). Any new agenda of responding to floods must relate conceptual advances, methodological breakthroughs, organizational mobilization, and attention to new areas of concern resulting from more complex social and environmental interactions. Broader policies and strategies should be considered in a manner that involves better hazard analysis, vulnerability analysis, the estimation of impacts, the identification of potential measures for minimizing losses, and selection and implementation of mitigation strategies. How people respond to hazards, how humans adjust to disasters, are parts of an increasing social sciences inventory. Yet, much needs to be learned about mobilization and implementation, comprehensive land use planning, new paradigms of complexity and global change, and development of cross-cultural data sets.

In terms of specific strategies and tactics, current concern once again is focused on the debate as to the primacy of *structural* vs. *non-structural* approaches. The strategies that are discussed continuously in the literature seem to represent policies that have been tried mostly locally or at the national level and tend to be much more responsive to short-term impacts. Indeed, existing policies and protection programs are mainly geared toward providing short-term disaster relief. All the above point out that there is a recognized need for anticipatory planning in order to be able to avoid later crisis-driven, reactive responses. The different adaptive mechanisms or adjustments call upon ingenious ways of preparing societies against short-term adverse impacts with little research being devoted to identifying and understanding societal adjustment to extreme events as well as long-term consequences of e.g. global climatic change. The institutional requisites for effective flood coping arise from a combination of strategies based on education, technological innovation, improved system management, the prohibition of certain activities, and comprehensive land-use planning. This is the spirit behind such efforts as those outlined in the report "Euroflood Project" (Attachment 10). The 1993 Midwest floods in the United States have pointed out to the need for contrasting flood control against flood management. This transformation is also taking place because on top of everything else structural solutions have also had significant environmental costs. The comparison and contrast of the two ways of managing a river has been succinctly summarized in a recent newspaper article (Attachment 11).

The conclusion to the above remarks becomes rather obvious. Recent writings point out that as a result of increasing complexification, uncertainty, and vulnerability, four types of interdependencies call for urgent intergovernmental integration: hydrological interdependencies; political interdependencies (both horizontal and vertical); transboundary interdependencies representing both social and hydraulic transnational linkages; and exogenous interdependencies, notably the potential dramatic impacts and consequences of climatic shifts and hydrological alterations.

Whether with logarithmic graphs, rigorous scientific analysis, or with speculative journalistic accounts the conclusion must be that hysteria, panic or overreaction are not the

proper responses to our shared concern with changing climate, recurring floods, or other extreme hydrologic events. There can be remedies for more prudent responses, including interdisciplinary research, expanded knowledge, sophisticated models that can make forecasts over decades, holistic vision, and broader new paradigms in science; strong conservation measures; detailed monitoring; institutional changes and international agreements enhancing the flow of information and the sharing of knowledge; and finally the establishment of long-term environmental scanning, and mobilization of people and organizations for concerted action.

Perhaps one way to summarize the responses and adjustments to floods is by developing a vigilance strategy. The concrete outcome would be a contingency planning posture involving three basic premises. The first would be expanded knowledge, allowing us to understand and forecast climatic changes, develop basic science, improve measurement, and utilize remote sensing data processing and information storage and retrieval technologies. The second premise is continued vigilance in terms of systems of monitoring and of assessing the consequences of different types of *natural* or *humaninduced* changes, especially through sensitive warning systems. The third premise of such a broad strategy is to increase our respect for nature by learning to live with a highly complex interrelationship of humans, biosphere, and climate.

5. REFERENCES

Alexander, David. 1993. Natural Disasters. New York: Chapman & Hall.

Blaikie, Piers, Terry Cannon, Ian Davis, and Ben Wisner. 1994. At Risk: Natural hazards, people's vulnerability, and disasters. London/New York: Routledge.

Blij, H.D. de. 1994. Nature on the Rampage. Washington, D.C.: Smithsonian Books.

Burton, Ian, Robert W Kates, and Gilbert F. White. 1978. The Environment as Hazard. New York: Oxford University Press.

Changnon, Stanley A. et al. 1983. A Plan for Research on Floods and Their Mitigation in the United States. Champaign, Ill: Illinois State Water Survey.

Clark, Champ et al. 1982. Planet Earth: Flood. Alexandria, Virginia:Time-Life Books.

Dept. Economic & Social Affairs. 1976. Guidelines for Flood Loss Prevention and Management in Developing Countries. New York: United Nations, Natural Resources/Water Series No. 5.

Lowenthal, David. 1990. "Awareness of Human Impacts: Changing Attitudes and Emphases." Pg. 121-135 in B.L. Turner H et al. The Earth as Transformed by Human Action. Cambridge: Cambridge University Press.

McDonald, Adrian, and David Kay. 1988. Water resources: issues and strategies. New York: Longman Scientific & Technical/John Wiley & Sons, Inc.

Milne, Antony. 1986. Floodshock: The Drowning of Planet Earth. London: Alan Sutton.

Palm, Risa I. 1996. Natural Hazards: An Integrative Framework for Research and Planning. Baltimore/London: The Johns Hopkins University Press.

Penning-Rowsell, Edmund C., and Maureen Fordham (eds.). 1994. Floods Across Europe. Middlesex University Press.

Petak, William J. and Arthur A. Atkinson. 1982. Natural Hazard Risk Assessment and Public Policy. New York: Springer-Verlag.

Rutherford H. 1986. "Floods and Man: A Geographer's Agenda." Pp. 28-67 in Geography, Resources, and Environment Volume H: Themes from the Work of Gilbert F. White, Robert W. Kates and Ian Burton (eds.). Chicago: The University of Chicago Press.

Robinson, Andrew. 1993. Earth Shock. London: Thames and Hudson.
Rossi, Giuseppe, Nilgun Harmancioglu, and Vujica Yevjevich. 1992. Coping With Floods. Boston/London: Kluwer Academic Publichers.
Smith, Keith. 1992. Environmental Hazards. London/New York: Routledge.
White,Gilbert F. 1945. Human adjustment to floods: a geographical approach to the flood problem in the United States. Chicago: University of Chicago, Dept. of Geography, Research Paper No. 29.
Wijkman, Anders, and Lloyd Timberlake. 1984. Natural disasters Acts of God or acts of Man? London: An Earthscan Paperback.

ATTACHMENT 1

SOCIO-ECONOMIC IMPACTS AND CONSEQUENCES OF EXTREME FLOODS
[An Outline Argumentation]

The Challenge of Floods

- Floods and society: periodic disasters and chronic hazards
- Apocalyptic floods as history and climate change as the current concern
- Extreme hydrologic events and the changing socio-ecological context: the continuous debate between structural and nonstructural approaches
- Vulnerability to floods: acts of "nature," or acts of "man?"
  Conflicts and floods: assigning blame
- The dilemma of floodplain occupancy

The Gamut of Flood Impacts and Consequences

- Flood perception and societal repercussions
- Towards a typology of flood events and severity of effects
- The enlargement of the spatial envelope: transboundary interdependencies and changing attitudes towards nature

Responding and Adjusting to Change

- The grand transformation: factors influencing short- and long-term responses
- Strategies and tactics: policies for structural, non-structural and mixed approaches
- The need for integrated water resources management
- The centrality of vigilance: implementing change

Implications of water related disturbances

		Land			Rivers and Lakes			
	wetter = + drier = –	soil moisture	groundwater	surface water	flow-related uses	carrier of effluents	use of water bodies	use related to water depth
Societal activities concerned		• agriculture • forests • buildings • roads	• rural water supply • local irrigation	• urban activities	• water supply • hydropower • irrigation	• sanitation • industrial waste water disposal	• fishing • recreation	• navigation
Problems encountered	+	• reduced fertility	• water logging • building damages	• urban storm runoff • erosion	• failing flow control • floodings		• erosion/ sedimentation • increasing currents • flushing of lake phosph.	• floodings, inundations
	–	• droughts • crop failures	• drying wells • pumping costs • foundation problems • subsidence		• water deficiencies • reduced hydropower production	• reduced dilution • aeration problems • unsafe for bathing	• changing fish population • reduced water removal	• collapsing navigation systems • reduced traffic
Engineering measures to mitigate	+	• drainage	• drainage	• urban drainage	• flow control		• river training	• increased levee height • reservoirs
	–	• irrigation	• deeper wells		• water transfer schemes	• flow control • waste treatment • aeration	• dredging	• flow control • barrages • sluices • dredging

ATTACHMENT 3

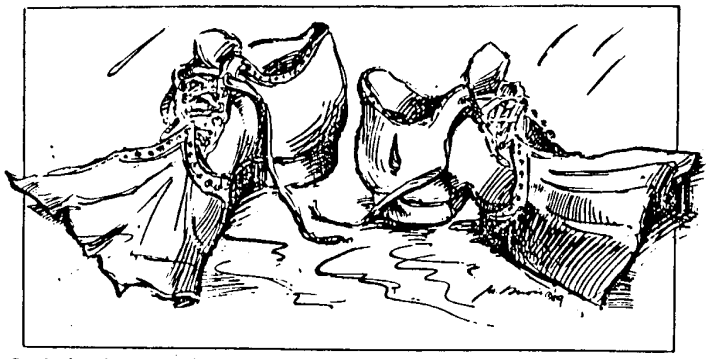
INTERLOCKING CRISES

- CLIMATIC SHIFTS
- MEGARUPTURES
- METABOLISM
- SOCIO-POLITICAL CONTEXT
- TRANSBOUNDARY DEPENDENCIES
- FAST PACE OF TECHNOLOGICAL DEVELOPMENT

 RUN 2/5/95

Floods force Europe to face up to its vulnerability

From The Economist magazine



As many people — more than 300,000 — fled from their homes in rain-sodden northwest Europe last week as lost their homes in the earthquake-shattered Japanese city of Kobe on Jan. 17.

The European death toll was, in comparison, tiny: Around 40 people have so far died because of the floods, compared with 5,100 or so killed by the earthquake.

Since the water in even the most swollen rivers stopped rising or even started to fall by last Thursday, most of the European evacuees, unlike the ones in Japan, should be able to go home within days or weeks.

But the message of the two events is the same. Even countries blessed with the best technology and the most sophisticated social machinery are vulnerable to the upheavals of nature.

In Belgium, half a dozen people perished because of bursting rivers; another 2,000 were moved out of their homes. France and Germany suffered more, with 43 of France's 96 *departements*, all in the country's northern half, hit by the worst floods since 1910.

In smaller French towns, mainly in the northeast, 40,000 homes have been under water. French insurers, at a rough count, say they may have to pay up to $568 million to repair the damage.

In Germany, parts of such ancient cities as Cologne, Coblenz, Mainz and Bonn have been deluged by the Rhine, which rose to within a whisker of its highest level this century. Around 30,000 German homes have been evacuated. The federal government has promised $20 million in low-interest loans to victims.

By far the most severely threatened country, though, is Holland, where more than a third of the country's 15 million people live below sea level.

The Dutch have defended themselves against the sea for centuries by an elaborate network of dikes 1,500 miles long. This time, however, the water came from behind, from a downpour in the Ardennes and a flood of melted snow in the Alps. More than 250,000 Dutch people evacuated their homes between Jan. 30 and Feb. 1, mostly from the Limburg region south of Nijmegen and from Zeeland, around Rotterdam, Europe's largest post.

It was Holland's biggest such operation since 1953, when the sea breached dikes in the south of the country, killing 1,400 people. In December 1993, floods caused $132 million of damage.

If the dikes collapse this time — as they were threatening to do — the damage, and loss of life, could be even worse, because the volume of water pushing against the ramparts is greater.

As with the earthquake in Kobe, the immediate cause of the flood was natural: drenching rain, snow melted by unexpected sun. But a number of manmade factors made the disaster worse than it would otherwise have been.

The Rhine, over the past few decades, has been put into a kind of corset. In the past, bulging waters would spill out into marshes and floodplains. These acted as sponges, soaking up surges of water. Since then, some of the waterlogged land has been dried out, cemented and asphalted, and buttressed with embankments to create residential and industrial property.

At the same time, changes in farming practices have made fields less absorbent, as hedges and forests are chopped down and farmers create prairie farms.

Above all, stretches of the Rhine have been straightened and banks heightened, cutting some 30 miles off the river's 820-mile meander to the sea. This has doubled the speed of the water's passage from Basle, at the Swiss border, to Rotterdam.

Now, when there is heavy snow or rain upstream, it cascades down to flood at the mouth or halfway along, instead of soaking into marshes nearer its source.

These man-created problems have made the river systems less able to accommodate flood waters than they used to be. But some ecologists argue that another change has meant there are more flood waters to cope with. The floods, they say, are a sign of a fundamental change of climate caused by global warming.

Most scientists have an open mind about this. Some insurance companies are closing theirs. "The almost regular floods in Europe could point to a possible global warming," says Munich Re, the world's biggest reinsurance company.

Such statements may nudge governments toward taking drastic — and costly — action. The pressure for governments to "do something" is greater because private businesses seem increasingly unable to cope with the problem on their own.

Insurers are becoming reluctant to cover flood damage. In Holland, it is virtually impossible to insure against flooding. In Belgium and Germany, insurance has been hard to find even though tax breaks were allowed to flood victims in 1993. Henceforth it will be harder still.

Since 1982, France has imposed a levy on insurance contracts which is put into a natural-catastrophe fund. The latest disaster could swallow up much of what remains in it.

So the arguments for direct government action may now be strengthened. The governments' advisers all say that only drastic remedies can make any real difference. But what remedies?

Some advocate building higher embankments and deepening rivers. The problem with this is that, where it has been done, in stretches along the Mississippi (which flooded disastrously in 1993) and China's Yellow River, it has produced rivers flowing many feet above the surrounding flood plain. As the levees are built up, sediment in the river bed grows too; the river beds — and the water level — rise. This leads to disaster when the barriers collapse.

Another, more expensive, idea is to build a relief channel to siphon off the Rhine when the delta near the sea becomes overloaded.

The most frequently canvassed solution is to give the rivers "more space," restoring them to nearer their original shape, and giving them back their sinuosity and seepage, regardless of habitation or insurability. This would require a greater degree of cooperation among the authorities responsible for controls over land use and flood controls.

In Germany, flood control is the responsibility of the states: They have been arguing about how much responsibility they bear for the floods.

Whatever the remedy, says Vujica Yevjevich, a Danube-born American academic, the diagnosis is clear: "We must review the entire philosophy of the last century for coping with floods."

New York Times Special Features

ATTACHMENT 4

Europeans point fingers over floods

By RICK ATKINSON
The Washington Post Feb. 1995

BERLIN — As floodwaters continued to recede across most of Europe on Friday, waterlogged communities from southern Germany to the Netherlands found themselves wondering how two "once-in-a-century" floods could hit the region within 13 months.

This week's torrent came as hundreds of thousands who live along the Rhine, Mosel, Main and other West European rivers had barely recovered from the devastating Christmas deluge of 1993. Damage from the two floods is likely to climb into the tens of billions of dollars.

Meteorologists and other scientists suspect that the catastrophic flooding is more than the result of just unusually heavy winter rains. Rather, a combination of urbanization, modern farming practices, navigation improvements and questionable floodplain management have rendered low-lying areas increasingly vulnerable.

Farmland and urban areas do not absorb water as effectively as land in its natural state, and many experts contend that decades of squeezing European rivers, particularly the Rhine, into an ever tighter corset have turned them into unstable funnels.

The *Sueddeutsche Zeitung* newspaper this week decried the "flood of sins and failures," and recriminations have flowed even faster than the water has ebbed. Dutch officials have been particularly biting in their criticism of upstream Germany for what they say is a willy-nilly approach to watershed conservation.

Neighboring governors within Germany traded potshots over flood-control procedures, while some critics question whether Germany's deep-rooted federalism, which gives great autonomy to individual states, has hindered sensible planning on a national scale.

By virtue of size and geography, Germany has tended to be both breeding ground and victim of the super floods.

One-eighth of Germany, which is roughly the size of Montana, lies beneath asphalt and concrete; every day, according to *Der Spiegel* magazine, another 225 acres is covered to make streets, parking lots or other urban ventures. Widespread deforestation has stripped the land of one of its most effective natural sponges. And many farms are now crisscrossed with drainage ditches that effectively remove water from crop fields by dumping it immediately into rivers.

Also a factor is the gradual straightening and channeling of the Rhine, Germany's mightiest river, which began in 1830. By removing bends and loops — south of Speyer, the river is 50 miles shorter than it once was — German engineers have given the river a greater capacity for barge traffic; they also have made it an effective conduit for shoving massive volumes of water into western Germany and the Netherlands.

At Karlsruhe in southwest Germany, for example, the Rhine crested at 26 feet above flood stage only four times in the century before 1977; since then, the river has hit that mark 10 times, according to *Die Zeit* newspaper.

One proposed solution is to create more polders, a kind of catch basin along a river that can be used to divert rising waters before they rampage out of control. But such safety valves are extremely expensive, and they often are resisted by local communities and farmers who do not want to see their fluvial plain converted into a swamp.

ATTACHMENT 6

ATTACHMENT 7

THE FIVE CRISES

- AN ENGINEERING CRISIS: SUPPLY & DEMAND
- AN ECOLOGICAL CRISIS: QUALITY
- AN ORGANIZATIONAL CRISIS: INSTITUTIONAL MOBILIZATION & COORDINATION
- A METHODOLOGICAL CRISIS: DATA & MODELING
- A PERCEPTUAL CRISIS: PUBLIC AWARENESS, INVOLVEMENT & PARTICIPATION

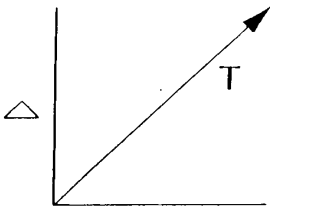
ATTACHMENT 8

FUNDAMENTAL CONFLICTS

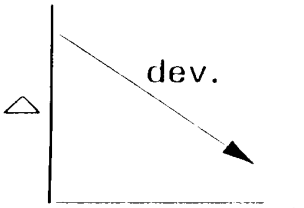
Ⓐ COGNITIVE CONFLICTS — [facts] — what we know
R+D

Ⓑ STAKEHOLDER CONFLICTS — [Parties-at-interest] — Participants who is affected
EMPOWER

Ⓒ IDEOLOGICAL CONFLICTS — [worldviews] — values, models of reality



Promethean
zoom-boom



Cassandra
gloom-doom

ATTACHMENT 9

THE GRAND TRANSFORMATION

- GLOBALIZATION
- INTERDEPENDENCE
- VULNERABILITY
- COMPLEXITY
- UNCERTAINTY
- TURBULENCE

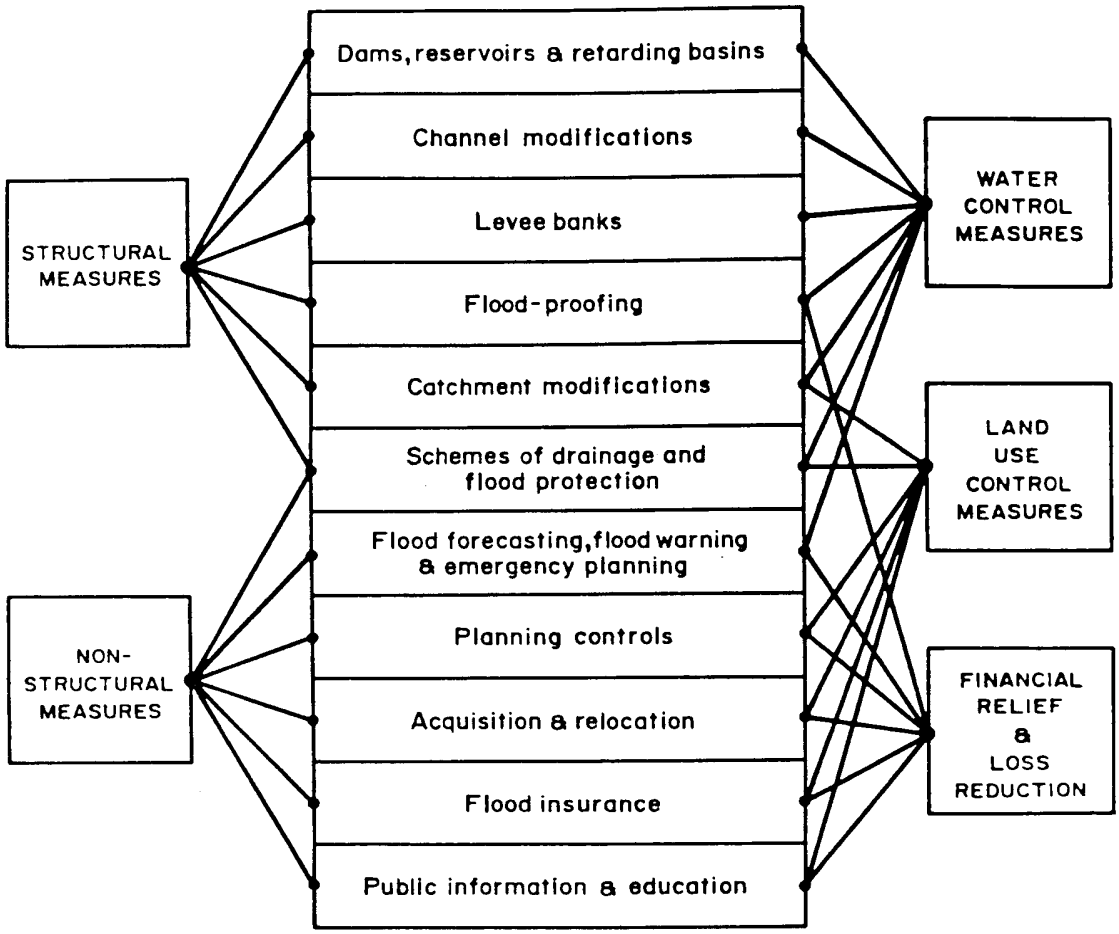
A. CONCEPTUAL = shifting paradigms/ complexity/chaos/ heterarchization

B. METHODOLOGICAL = multi-/GIS, ES, AI, DSS/systems/computational prowess

C. ORGANIZATIONAL = participatory/ anticipatory/contingency

D. SUBSTANTIVE = new focus/areas of concern

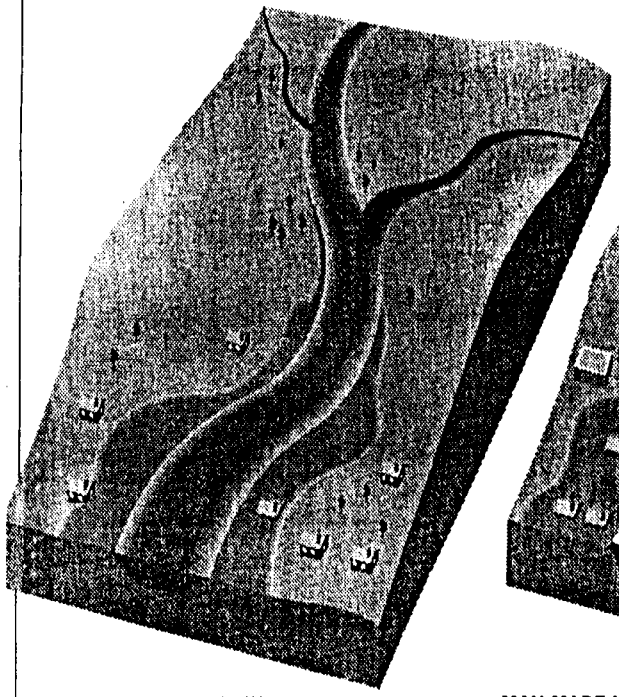
ATTACHMENT 10



Alternative flood alleviation strategies: listing the solutions is simple; it is the implementation that brings the problems.

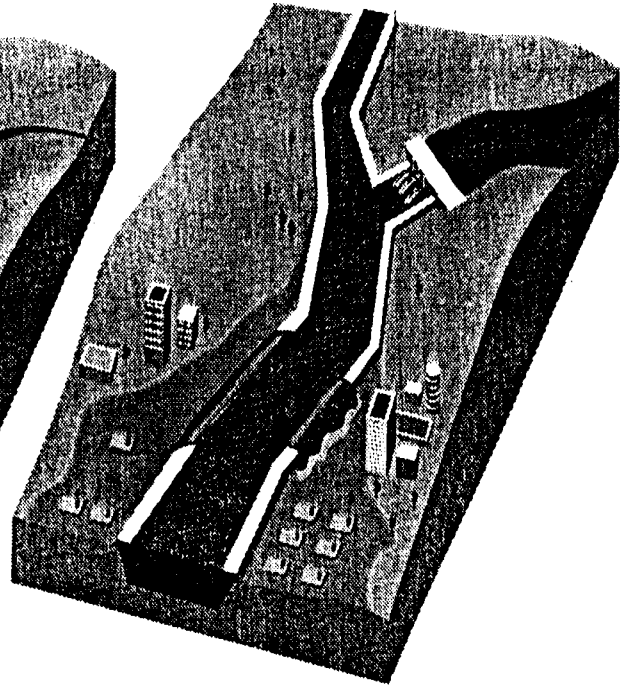
COMPARE AND CONTRAST

Two Ways of Managing a River



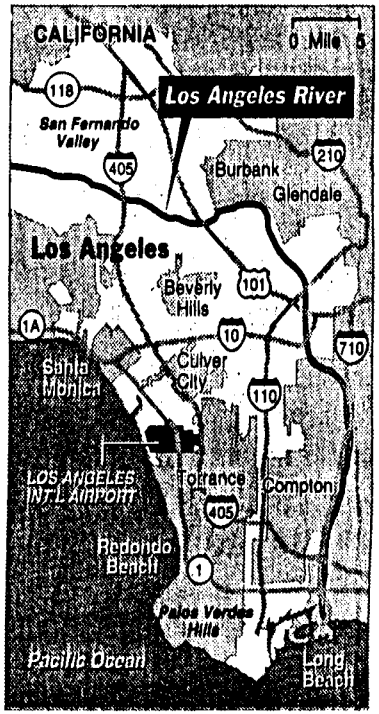
NATURAL FLOOD PLAIN

Floods are more frequent, but less devastating because flood waters have space to spread out. Buildings must be situated away from riverbanks to avoid water damage.



MAN-MADE LEVEE OR CULVERT

Floods are less frequent, because high walls hold back rising waters. However, the walls constrict the river, increasing the current's force. If the river breaches the walls, the resulting flood waters can cause much more damage than a non-constricted river.



The Los Angeles River is one such channel. In urban areas, the river flows through a concrete culvert. Most years, it is only a trickle, but becomes a torrent during floods.

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