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Preface

e loss of life and devastation in the Gulf Coast region of the United States following the hurricane season of 2005 have led to considerable debate about what should be done and not done in recovering from the damage. is paper reports the experiences of recovery from four major floods since 1948, to see whether there are lessons from these experiences that might apply to the Gulf Coast recovery e ort. e cases are

Vanport, Oregon, where the Columbia River broke through a protective dike on 30 May 1948

e Dutch province of Zeeland, where high tides and a huge storm overwhelmed the sea defenses on 31 January 1953

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Summary

Introduction

is occasional paper presents a historical analysis intended to seek insights that might guide current reconstruction e orts in the Gulf of Mexico coastal region of the United States in

We cast our examination within a seven-step analytic framework that is based on a *cycle of restoration*, as illustrated in Figure S.1. e cycle may be roughly divided into three stages: (1) *anticipation* of the next possible flooding event, (2) the *actuality* of the event, and (3) the *aftermath*.

Planning. Before an event threatens, there should be planning about what to do when the next event comes.

Detection. An ongoing information-gathering system is required, to provide warning of when and where an event will take place and also to monitor prevention and mitigation systems.

Preparation. When an event is imminent, preparation should intensify. Lines of communication must be put in place, needed resources marshaled, and evacuation and other contingency plans set in motion.

Compensation. Compensation, broadly defined to include public and private insurance payouts and other public assistance, is closely tied to reconstruction decisions. Where reconstruction is not completely possible or desirable, social insurance of some form can compensate individuals and businesses for their losses.

Learning and implementing lessons.

induces further development. Instead, decisionmakers need to choose structural elements that are compatible with nonstructural approaches intended to achieve other longer-term economic, environmental, and social objectives. Although this lesson has evolved in the past century from being implicit to being explicit, it is still salient as long as the Army Corps of Engineers continues to play a dominant role in flood management in the United States.

Compensation was not a major feature in the Zeeland and Yangtze cases and was a sore point that could not be resolved in the Vanport case. e Mississippi case provides the leading lesson, and produced strong recommendations in terms of who takes responsibility for risks and the relationship of insurance and government compensation after losses. ese recommen-

ticularly in developing logistics for deploying supplies and personnel in advance. Although scenario planning had been employed by FEMA, it will need to anticipate a wider range of scenarios in the future to fully prepare its sta for a wider range of catastrophic conditions in major metropolitan areas.

Detection of the storm itself was certainly adequate in the case of Katrina—as it was in the historical examples—but detection fell short in anticipating structural failures and collapse under the forces unleashed by the storm. In the case of New Orleans, as with Vanport, the Corps and the local levee districts had no monitoring equipment in place to detect structural weaknesses, soil anomalies, and impending failure. is shortcoming can be remedied through deployment of sensors on all structural features of the flood protection system.

e examples suggest that decisions about how to proceed with *reconstruction* in the a ected areas are strongly influenced by the answer to the question of what the level of flood protection will be in the future. In the four cases we examined, this decision was intimately

flood protection measures, reforms in building codes, and enlightened land-use planning that will reduce their exposure in the future, assuming they choose to continue to serve the region.

is issue is clearly an important area for future analysis and policy change.

Final Observations

We close with some final general observations that span the cycle of restoration.

> George Santayana (1905) said, " ose who cannot remember the past are condemned to repeat it." is has clearly been shown in our case studies. Attending to history leads to mitigating the potential damage of floods even when major floods are few and far between; ignoring history leads to even larger disasters. Whether the Gulf Coast region

Acknowledgments

e genesis of this paper was an idea of Jim omson (CEO of RAND) that a historical look at how people recovered from flood disasters might o er insights for how to recover from the Gulf Coast catastrophe. We thank Jim for the idea and his willingness to support this e ort. We benefited from sharp, constructive reviews of an earlier draft by Jim Bigelow of RAND and Gerry Galloway of the Industrial College of the Armed Forces, National Defense University and formerly Executive Director of the Interagency Floodplain Management Review Committee that investigated the 1993 Mississippi flood. We also benefited from less extensive but valuable comments by George Penick, Jack Riley, and Mike Toman of RAND. Miriam Polon's editing improved the readability of the paper.

Abbreviations

Corps	U.S. Army Corps of Engineers
CWRC	Changjiang (Yangtze) Water Resource Commission (China)
EEED	Environment, Energy, and Economic Development Program (RAND Corporation)
FEMA	Federal Emergency Management Agency

CHAPTER ONE

Introduction

In the literature of addressing the threats and consequences of floods, this evolution has been expressed as a shift from a near-exclusive focus on structural ways of controlling floods (such as building dams, levees, and the like) to integrated water resource management (IWRM). IWRM policy takes into account

e ciency, to make water resources go as far as possible
equity in the allocation of water across di erent social and economic groups
environmental sustainability, to protect the water resource base and associated ecosystems.

In an IWRM policy regime, safety is managed not only by structural measures but also by such nonstructural flood control systems as laws and regulations, administrative management and economic levers, and technical measures other than construction. Moreover, safety is only one aspect of water management; IWRM also seeks to balance environmental, economic, environmental, and cultural values. An integrated approach is increasingly recognized as a crucial support for structural systems in order to reap full benefits and achieve desired results from structures. It also provides risk management for flood control zones, especially in areas su ering from frequent flooding. Popular examples of nonstructural safety tools include zoning to prohibit development of floodplains and flood insurance requirements. More integrative systems include storm surge barriers instead of or in supplement to levees to provide environmental sustainability and economic development of floodplains. ese types of measures incorporate the understanding that part of the time the plain will be under water.

Compensation. Compensation, broadly defined to include public and private insurance payouts and other public assistance, is closely tied to reconstruction decisions. Where

anticipation and better handling of the actuality of the next event. Improvements in the form of changes to the status quo ante, which are often di cult to convince people to accept under

Company was quickly able to mobilize buses to transport Vanporters to hastily-set-up shelters in the city, and the citizenry responded to the victims generously (American Red Cross, 1948; Maben, 1987; George, Washington, and McGregor, 2005).

Aftermath

e remarkable aspect of Vanport, and the one that makes this case worthy of study, is that it was not rebuilt. ere was an ambivalence toward the community throughout its entire brief existence, brought on by a number of factors (Maben, 1987; University Park Community Center, no date):

> Vanport was built to house immigrants to the area, and Oregon has had a historic antipathy toward newcomers.
>
> e governance of Vanport was unique, to say the least (Maben, 1987). e city was built as a federal housing project, and the government owned all the buildings and their contents. Residents rented their apartments from the government at a rental rate considerably less than the open market in Portland. Although Vanport was carefully separated from Portland and was never o cially incorporated or annexed, the Housing Authority of Portland exercised governing authority over the community.
>
> A considerable number of the newcomers were black, and although the housing was nominally not segregated, de facto black neighborhoods within Vanport were the rule.

Maben, 1987; University Park Community Center, no date). is included the black popula-

As a case study, Vanport serves as a proof of principle that if the social, political, and cultural circumstances permit, the cycle of restoration need not be an attempt to restore the status quo ante but can instead be an impetus for going forward to achieve broader societal values.

Zeeland

Zeeland is the southwesternmost province of the Netherlands; it is a largely agricultural area that is open to the sea and cut by deltas of three di erent river systems (the Rhine, the Maas, and the Schelde). Most of the land lies below sea level, and dikes have protected the land from the sea for centuries. In the middle of the night of 31 January 1953, high spring tides combined with strong winds to create a huge North Sea storm that overwhelmed the southwestern quarter of the Netherlands (Deltawerken, no date [a]) (Figure 2.3). Almost all the province of Zeeland was flooded, some of it severely. ere were 1,835 people who died; 72,000 were

Figure 2.3
The Netherlands

RAND *OP164-2.3*

ferring the water problem downstream." If construction results in endangering the safety of the region or worsens water-related problems, the initiator of the construction will be liable (Ministry of Transport, Public Works and Water Management, 2000).

inking about the Delta region continues to this day. Although the Delta Works project was successful in meeting its original objective, new threats have emerged with time and increased knowledge. e land is sinking, the water level is rising, and the economic and social investment in the lowlands has increased; this implies more frequent flooding in the future that will have more severe consequences (Ministry of Transport, Public Works and Water Management, 2000). With recognition that traditional structural measures alone cannot deal with these threats, the Dutch created an updated version of the Delta Commission, which concluded in 2000 that new, integrated water resource management was needed (Dialogue on Water and Climate, 2002). In what is a remarkable revolution for the Dutch, this new group proposed not only spatial planning and land use measures but also that some land wrested from the sea be returned. In its new approach to integrated water management, it has planned to "give room to water." is principle is well implemented in the institutional structure of the Dutch spatial planning but not on the local policy level (Cooperative Program on Water and

Native Americans have lived in the upper, middle, and lower Mississippi basins for more than 1,000 years. ey built their houses on relatively elevated lands, fished from the rivers, farmed on the floodplain, and used the floodplain resources as building materials. Flooding was part of their cycle of life, with few long-lasting consequences except for extreme events, in which case the survivors moved (Changnon, 1996c).

e National Weather Service (NWS) is tasked with preparing river flood forecasts and informing the public about the height of the flood crest and about the date, time, and duration of the expected flooding (U.S. Geological Survey, no date [b]). In 1993, the NWS worked with the U.S. Geological Survey (USGS) to collect and use recent hydrological data. USGS experts visited the stream-gauging stations in the flooded and flood-prone areas several times to measure river discharges and to check the instruments and repair them if necessary (USGS, no date [b]). e NWS, for its part, issued river flood warnings during the spring and summer of 1993. e information provided by both these agencies was used by the Corps—for example, to schedule reservoir releases; by FEMA—to reply to emergency need before, during, and after the flood; and by many state and local agencies dealing with flood management and mitigation (IFMRC, 1994; U.S. Geological Survey, no date [b]).

Evaluations of the quality of service provided by the NWS are controversial. Supporters believe that the small number of people who died in the flood is directly related to the early and accurate river flood forecasts (U.S. Geological Survey, no date [b]). Critics, however, believe that a large proportion of economic losses could have been prevented if the NWS had provided earlier and less optimistic warnings (Changnon, 1996a). ey argue that, several times, the NWS made overly optimistic estimates that discouraged residents and businesses from taking proper preventive and mitigative actions. ey claim that the models used to predict floods for

floods about the latest news to decrease their stress about what might happen to their monthly income, monthly rents, and insurances. Other firms donated cellular phones to city o cials and to the Red Cross to improve communications. Daily newspapers listed resources ranging from temporary housing to child care services and were provided free of charge in refugee centers (Greenberg and Shell, 1993). Politicians reinforced the relief e orts with tours of the region and inspections.

At the peak of the flooding, all the transportation modes in the region were paralyzed. Considerable e ort was expended to restore the operation of the transportation sector as soon as possible. River transport was the first to be abandoned, but the Coast Guard and Corps o cials established a center to develop plans for quickly reconstituting service. e rail sector established "situation rooms" to deal with emerging problems and to restore operations. Road transportation o cials engaged in a triage of damage, temporarily repairing highly critical segments and postponing permanent repairs because of the high soil moisture and the possibility of winter floods (Changnon, 1996b).

ere were intensive mitigation e orts for the social infrastructure as well. Physicians, nurses, medical equipment, and supplies were immediately sent to the region, and the restoration and rebuilding of the primary health care services and systems was a high priority. A Midwest flood health and medical task force was formed through the Public Health Service's O ce of Emergency Preparedness to deal with primary care, mental health, food safety, envi-

> Apparently, we have learned nothing from the flood. Factories, warehouses, shopping malls and gambling casinos are being built on flood plains up and down the Missouri and Mississippi. . . . All this is going on with no real planning or region wide risk assessment. (*St. Louis Post-Dispatch*, 2004)

Following the 1993 flood, the federal government asked the Interagency Floodplain Management Review Committee (IFMRC, also known as the Galloway Commission after its chairman, Gerald Galloway) to provide advice on how to improve prevention (IFMRC, 1994; Galloway, 2005a). e IFRMC called for major changes in the structure of U.S. floodplain policy, including changes that would result in less development in the floodplains and changes that would increase individual responsibilities (Galloway, 2005a). In response, many agencies started to adopt more nonstructural floodplain management approaches, and the federal government decided to create policies to decrease the population living and working in areas at

erty owner to any further risk. In response, in 1973, Congress made participation in NFIP

Yangtze

Snaking its way over 3,900 miles from western China's Qinghai-Tibet Plateau to the East

Figure 2.6
Affected Regions in the 1998 Yangtze Flood

occurred in 1998 (Figure 2.6); previous major 20th-century floods occurred in 1911 and 1938. In the 1998 flood, 1,562 people lost their lives (compared with 1.4 million in the 1911 flood), most from debris flows in mountain regions. A total of 81,853 square miles (21,200,000 hectares) of land was flooded, with an estimated economic loss of RMB 166.6 billion (US $20.5 billion) (Zong and Chen, 2000).

Anticipation

The Changjiang (Yangtze) Water Resource Commission (CWRC) has had responsibility for flood control of the Yangtze basin for decades, dating back to a 1959 systematic plan for flood control (Ministry of Water Resources, 1999).

In January 1998 (before the 1998 flood occurred), the Chinese government established the first national law for flood prevention (Zhang and Wen, 2001). The law both clarified

responsibilities among national and local authorities for flood management and established a set of regulations for control. ese regulations limit the land that can be reclaimed from water, promote relocating residents of retention basins to safer places, and give the central government authority to decide whether or not to use retention basins (Ministry of Water Resources, 1999).

the Central Committee of the Party. Cutting-edge information technologies, which included the meteorological satellite communication systems, the automatic hydrological telemetry systems, the remote-sensing systems, and the satellite positioning systems, played a crucial role in fighting the flood (Academic Divisions of the Chinese Academy of Sciences, 2005). Di erent government institutions throughout the country all proactively got involved in the flood control e ort. anks to these early warnings and preparation e orts, emergency rescue and preservation e orts were largely successful. e loss of life was remarkably small compared with previous large floods along the river. Indeed, most of those who perished did not live in the floodplain areas where casualties had previously been highest but instead were victims of mudslides in the elevated regions above the floodplain. e percentage of regional economic assets lost was smaller than in previous floods, although the total economic losses were higher than historical levels because of the magnitude of economic development that had occurred over the past several decades (Wan, 2003).

Aftermath

After the Yangtze flood of 1998, the Chinese government appropriated RMB 10.1 billion (US $1.22 billion) for the implementation of the "Resettlement in the Stricken Areas Project." e Ministry of Civil A airs was the leading ministry for rehabilitation of villages and towns; the Ministry of Construction was responsible for the village relocation projects and infrastructure works. e latter ministry formulates general guidelines, whereas the specific layout plans for the new villages are prepared at the provincial level by professional planning and design institutes. e government established a policy that recovery e orts should not simply restore the a ected areas to their pre-disaster conditions but should aim at improved living conditions for the people and should support complementary development initiatives. Furthermore, reconstruction and rehabilitation should take place in the original location of the settlements whenever possible. Settlement relocation would be considered only in exceptional cases where the original settlement was located in a high-risk area (e.g., lowlands next to a river, or islands in the river, which require major protective embankments that would have significant impact on the natural flow of the water) or in areas to be reclaimed by river channels or lakes (Li, 2000).

By December 1998, the government had already selected the new sites for the villages

those of 1998, demonstrated the e ectiveness of structural and nonstructural policies and measures to reduce casualties and economic loss (Department of International Cooperation and Technology, 2004).

Demolishing polder fields to release floods and converting farmland into lake area. Based on preliminary statistics, in the 1998 floods, over 2,000 dikes broke in the lower and middle

within a culture that is accepting of top-down direction and control to an extent that is unacceptable in most Western cultures, much less the American one. e challenge of this case is to find ways of incorporating the desirable elements of water management found here through a system of individual incentives and decentralized government policies. Although this task is di cult, the benefits of achieving it make the e ort worthwhile.

CHAPTER THREE

Synthesis of the Lessons from the Case Studies

e four cases that we have examined are all illustrative of the evolution in thinking about flood management that has taken place in the past 60 years and that has led to new ways of thinking about future floods. In this chapter, we proceed through the cycle of restoration to synthesize the lessons learned from the four case studies. In Chapter Four, we present conclusions from this synthesis that apply to the restoration of the Gulf Coast region following Hurricane Katrina.

Planning

e cases show, through both omission and commission, the value of advance planning. Even though our cases were selected because they represented extreme floods within their respective regions—where even planning could not have entirely averted damage—they nevertheless show the advantage of considering potential problems and creating policies to address them. e Yangtze case illustrates this best: e policies and response organization that were put into place paid major dividends when the floodwaters arrived. e Zeeland case also illustrates this from the opposite viewpoint: Ignoring warnings for decades meant that the population was essentially helpless against the onslaught of the storm. Vanport shows that where planning was adequate (i.e., the larger Columbia basin area), mitigation was generally successful, but where planning was inadequate (i.e., Vanport specifically), the e ects were disastrous. For the 1993 Mississippi flood, planning based on lessons learned from previous river floods made detection, preparation, and first response better than they otherwise would have been.

Detection

In each of these flood-prone regions, the question was not *whether* flooding will happen but *when* it will happen again. Modern technology has been brought to bear, including satellite weather observation and improved modeling of storm and river flow patterns, as well as communication technology to get word of the threat to those people who are at risk. e Mississippi and Yangtze cases both benefited from use of this technology, and the Zeeland case provided an impetus for aggressively improving detection and communication capabilities. In the Vanport case, detection of rising flood levels was not a problem, but detection of structural

Reconstruction

Reconstruction e orts in the sense of reestablishing the functions of everyday life were addressed

At first, the thinking was in terms of protection from a repetition of the flood, at almost any cost. However, with time and the innovative potential of technological advancement, Dutch

natives that may conflict with local land use prerogatives. Although the Corps has long used property buyouts as a tool to reduce risks from flooding, it cannot easily employ that tool on anything but a small scale because of political and financial constraints.

Several overarching lessons can be drawn from the examples:

Building bigger and better flood protection works does not necessarily maximize safety. Surrendering land to the water in the form of forgoing development of floodplains or active removal of formerly reclaimed land can lead to reduction in property loss and lives at risk.

Di ering perceptions among residents and political leaders of permanence and transience of the physical environment can create conflicts in decisions about what to rebuild, what to modify, and what to leave as is.

CHAPTER FOUR

Lessons for the Aftermath of Katrina

We undertook this historical analysis to seek insights that might guide current reconstruction e orts in the Gulf Coast region in the aftermath of Hurricane Katrina, which struck in the late

and reduction in the city's protection from storm surges. On the coasts of the Gulf of Mexico, storm surges had been anticipated, but not at the heights wrought by Katrina (White House, 2006). In the future, regional leaders should consider policies and plans that are more robust against a wider range of disaster scenarios.

roughout the region, however, the biggest blind spot was the failure to anticipate the possibility of widespread regional breakdown in infrastructure and services and the disabling of first-response and public safety systems. Some activities, such as evacuation planning, simply cannot be implemented on the fly. Evacuation services for all segments of the population must be worked through in su cient detail well in advance of the event. e fragility of many structures on the Gulf Coast, along with the fact that so many of them were built to out-of-date building codes, underscores another opportunity for improvement. Here, the lessons of history are that, while determining safety levels might be defensible on cost-benefit or IWRM bases, the planning for regional infrastructure and services must cover total catastrophic breakdown and must include secondary, contingency responses that can be invoked when primary responses are overwhelmed. In Zeeland, lack of such planning led to catastrophe, but in the

have choices of where to live within the United States in ways that the Dutch did not perceive that they had. is psychological di erence casts the public decision about the appropriate level of flood protection in more complex terms.

reforms in building codes, and enlightened land-use planning that will reduce their exposure in the future, assuming that they choose to continue to serve the region. is issue is clearly an important area for future analysis and policy change.

Final Observations

We close with some general observations that span the cycle of restoration.

- George Santayana (1905) said, " ose who cannot remember the past are condemned to repeat it." is has clearly been shown in our case studies. e Zeeland and Yangtze cases show that attending to the lessons from past flooding leads to an ability to improve on historical outcomes. e Mississippi case shows that not following up on the lessons of past flooding leads to avoidable damages. Attending to history leads to mitigating the potential damage of floods even when major floods are few and far between; ignoring history leads to even larger disasters. Whether the Gulf Coast region will adequately attend to its recent flooding history remains to be seen.
- e critical concept of integrated water resource management policy—particularly its implication that flood control includes conceding land to the water from time to time—is a psychologically and politically di cult one. is is a problem that goes well beyond flood control. In almost all areas of preventive policy, there are times when an excess of cure can be worse than the disease. Increased development induced by structural barriers such as levees often adds to risks from flooding.
- Advanced delineation of roles and responsibilities shapes outcomes. As with any large-scale events, there were many di erent actors in each flood—national governments, local governments, engineers, the private business sector, and communities. When those actors had well-defined and well-understood roles, things generally went well. However, when such definition and understanding were lacking, the consequences of the disaster were magnified. e flooding of New Orleans shows that this lesson has yet to be fully absorbed for disasters in which local capacity is overwhelmed and the impacts are regional in their scope.
- Out of tragedy can come opportunity. In each of the cases, there were improvements to the social and physical infrastructure in the reconstruction phase that went beyond flood protection. is shows that disruption of the status quo can create political conditions for broader-based social and economic change that might otherwise have been delayed or not happened at all. It is still too soon to tell whether this latest cycle of restoration in the Gulf Coast region will lead upward or downward.

In sum, the cases provide a su ciently diverse set of circumstances from which to draw useful similarities and contrasts to the current situation in the Gulf. While social, economic, environmental, and political conditions before the disaster provide the stage and the props for the post-disaster response and reconstruction e orts, the cases clearly show that the past need not be prologue.

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