RISING CURRENTS

PROJECTS FOR NEW YORK'S WATERFRONT

MoMA

BARRY BERGDOLL

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The Museum of Modern Art, New York

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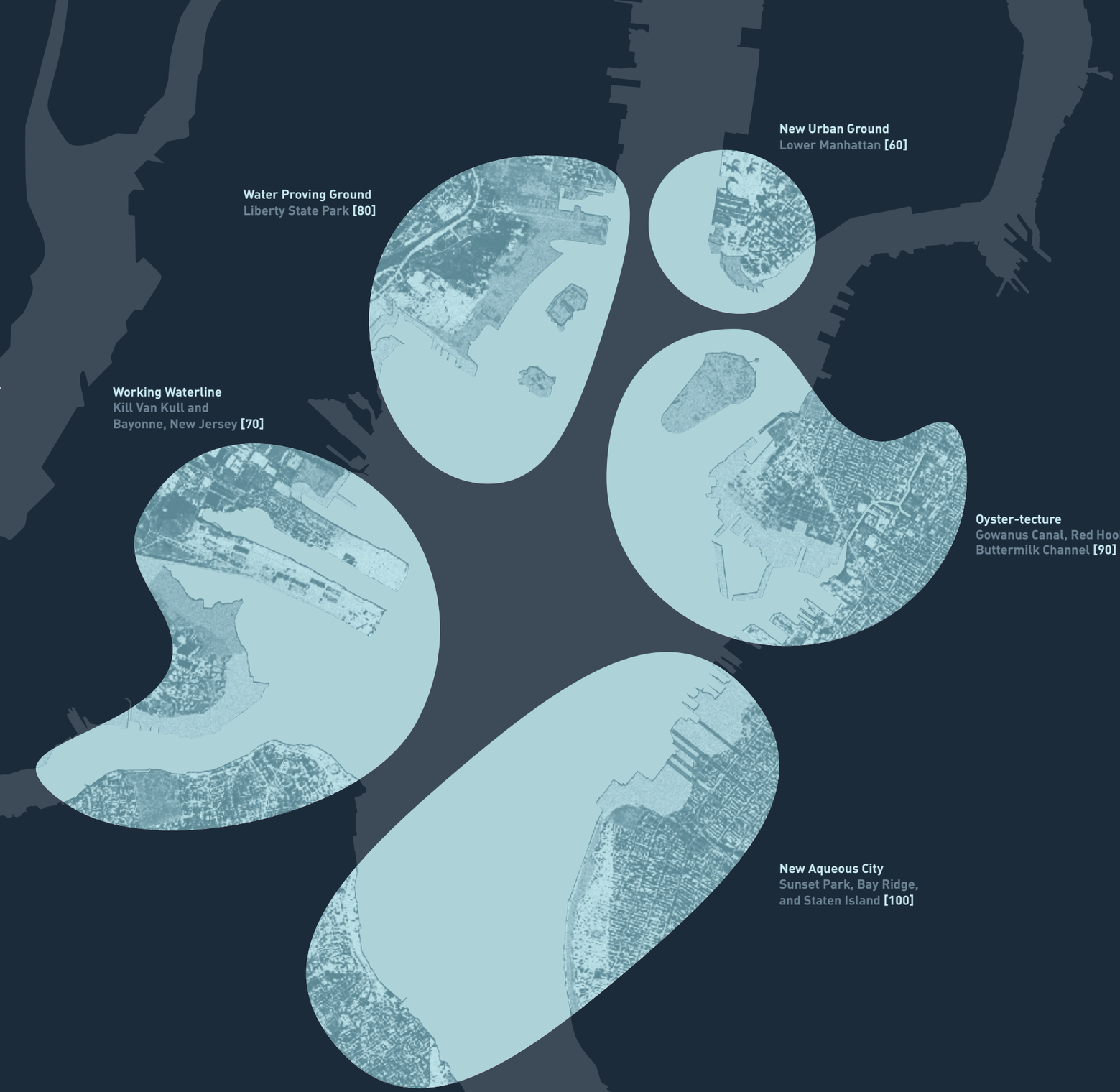

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FOREWORD

Even in light of The Museum of Modern Art's history as an advocate of cutting-edge research and social advocacy in architecture, *Rising Currents: Projects for New York's Waterfront* has been a bold experiment. In the years since its founding, in 1929, the Museum has urged designers and administrators to channel the profession's explorations toward the important challenges of the moment. In the 1930s the newly created Department of Architecture played a key role in the housing debates and legislation of the time with a series of exhibitions including *Housing Exhibition of the City of New York* (1934); it furthered this role in 1967 with *The New City: Architecture and Urban Renewal*, a landmark critique of inner-city transformation through large-scale demolition. In *Rising Currents*, a rejuvenation of this tradition, the Museum set one of the most urgent problems in design today—ameliorating the effects of global climate change—before five interdisciplinary teams of architects, landscape architects, engineers, ecologists, and artists, committing to exhibit the results even before design work had begun.

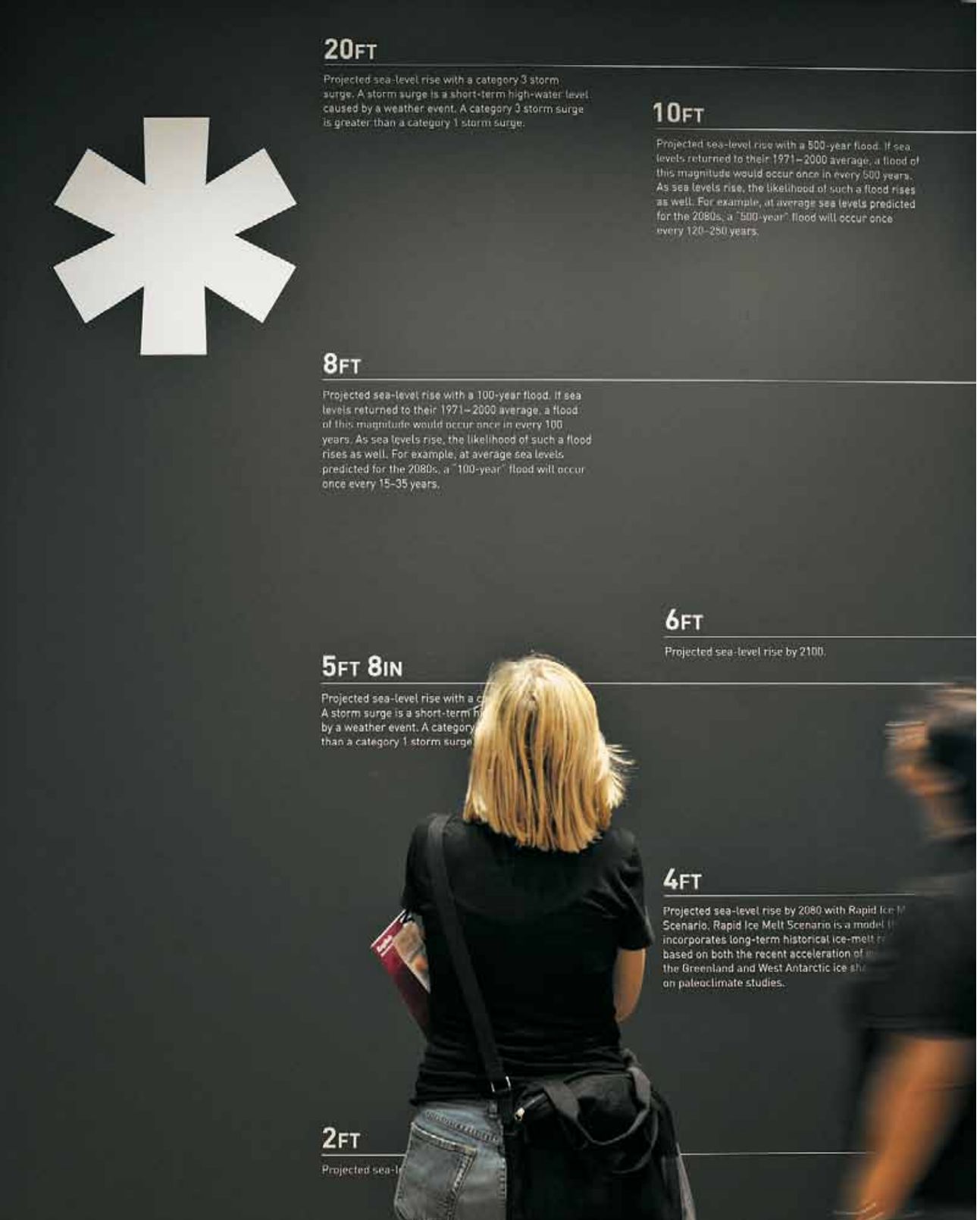
Rising Currents calls for the reinvention of urban infrastructure in the face of the effects of rising sea level on the world's great cities, many of which are situated in low-lying coastal areas. It is the first exhibition in MoMA's new Issues in Contemporary Architecture series, in which the Museum will take a leadership role in responding to contemporary developments and demands. In collaboration with MoMA PS1, the project also inaugurated the workshop-exhibition, making studio spaces that have long served artists available to architects and designers, thus putting creative and cutting-edge design work in direct contact with policy makers and the public.

This publication presents the five teams' proposals for New York City and is a record of the lively discourse around urban infrastructure design that took place during the workshop, throughout the exhibition at MoMA, and on the interactive pages of the project's website.

Rising Currents open houses and events attracted visitors at every level, from interested citizens to officials of the city, state, and federal governments, and the project's influence is already in evidence—it is acknowledged, for example, in 2011 planning documents of the New York City Department of City Planning. This volume is intended to extend the impact of *Rising Currents* so that it may serve architecture students, public officials, designers, and others who work in areas that demand interdisciplinary thinking.

Barry Bergdoll, The Philip Johnson Chief Curator of Architecture and Design, conceived *Rising Currents* and ably organized it from inception to realization, aided by Emma Presler, Department Manager, Department of Architecture and Design. I am grateful to him for bringing this precedent-setting project to fruition and to Guy Nordenson, Catherine Seavitt, and Adam Yarinksy, authors of the 2007–09 study *On The Water: Palisade Bay*, which provided both the data and the manifesto on which the entire experiment was based. On behalf of the staff and trustees of the Museum, I would like to thank Andre Singer and The Rockefeller Foundation for their indispensible support of the exhibition and this publication.

Glenn D. Lowry
DIRECTOR, THE MUSEUM OF MODERN ART



PREFACE

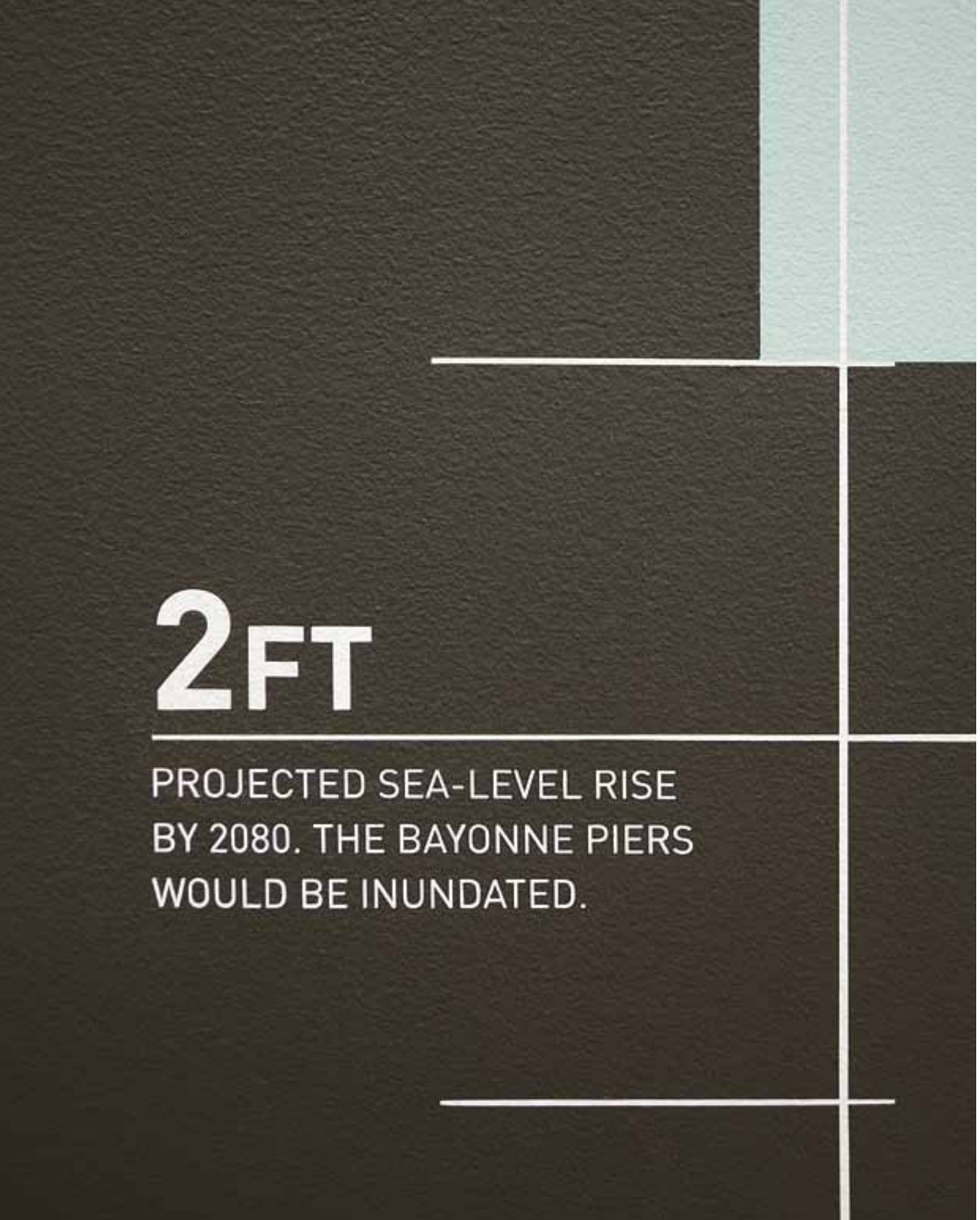
For millions of people around the world, the consequences of climate change will become increasingly evident and increasingly devastating. Higher temperatures will create more droughts and lead to the spread of heat-related diseases. Harsher storms will lead to flooding and the loss of crops and safe drinking water. All of this, taken together, will mean the destruction of homes, jobs, food, and—tragically—lives.

This prediction, though dire, is an opportunity. *Rising Currents: Projects for New York's Waterfront* confronts the threat of climate change head-on, turning the risks into incentives to create a more inviting, livable, and resilient world. In 2009–10, five multidisciplinary teams of architects, landscape architects, engineers, ecologists, and artists were challenged to reenvision areas of coastline around New York City in light of rising sea level and more frequent extreme weather events—the results of climate change. Their proposals, presented in this volume, paint a picture of a dynamic, flexible, and green city, a city in which new juxtapositions of water and land form recreation spaces, native plant species flourish in their original habitats, and toxic sites have been repurposed into clean-energy hubs. Lower Manhattan is a Venetian landscape, in which amphibious "green" streets are lined with porous pavement. Giant interlocking forms made of recycled glass slow coastal storm surges, an aquatic amphitheater rises out of the water, and the Bay Ridge Flats are once again inhabited by oyster beds, which decelerate storm currents and cleanse the river. These innovative design solutions were conceived in an architects-in-residence program and design workshop led by Barry Bergdoll, The Philip Johnson Chief Curator of Architecture and Design at The Museum of Modern Art, New York, hosted by MoMA PS1, in Long Island City, Queens, and financially supported by The Rockefeller Foundation. The teams were visited by city officials, climate scientists, and, during two open houses, members of the public; this feedback was crucial as the designers developed their proposals. The resulting exhibition at The Museum of Modern Art was organized by the teams in conjunction with Bergdoll.

The Rockefeller Foundation is proud to support this pioneering project as part of our broader initiative to promote climate-change response nationally and internationally. It is our ongoing mission to help the economically vulnerable tap into globalization's benefits and strengthen their resilience to risk, and we are committed to the support of New York City's diverse cultural institutions, which play a fundamental role in promoting innovations that have societal benefits both immediate and long-term. The iterative multidisciplinary design process embodied in this catalogue is the hallmark of effective approaches to complex systems problems. It is a valuable model for citizens, governments, businesses, and others working together to tackle the persistent problems society faces.

And climate change is indeed a complex problem of global proportions. It requires us to fundamentally reconsider where and how we live as societies; demands that we reinvent infrastructure design to meet the more variable conditions cities will face in the future; and necessitates flexibility, resourcefulness, and robust and redundant systems that continue working even when stressed and bounce back rapidly when damaged. The exhibition and this catalogue inspire us to face the climate challenge and transform it into an opportunity for safer and greener cities that are more equitable, livable, and competitive. This is a challenge—and an opportunity—we cannot afford to ignore. We congratulate MoMA and the enterprising design teams featured in *Rising Currents* for opening up a pathway to resilience and inspiring others to follow.

Dr. Judith Rodin
PRESIDENT, THE ROCKEFELLER FOUNDATION



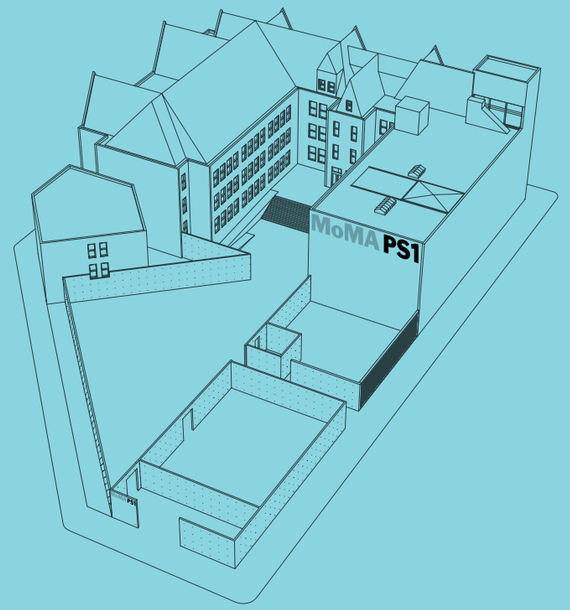
SEPTEMBER 21, 2010

At the US Environmental Protection Agency (EPA), our mission is to protect human health and the environment, and taking action on climate change is a top priority. But the task of mitigating and adapting to climate change is far bigger than any one agency. As *Rising Currents* illustrates, this undertaking will cross jurisdictional boundaries throughout the New York Harbor and involve contributions from across our society in ways that transcend conventional thinking. We welcome creative solutions to this far-reaching problem and look forward to working together with all those who strive to create a better future.

—Daniel Teitelbaum, Program Analyst, US EPA Region 2, New York, on the *Rising Currents* blog

RISING CURRENTS: INCUBATOR FOR DESIGN AND DEBATE

Barry Bergdoll



MoMA PS1 is The Museum of Modern Art's contemporary art affiliate in Queens, New York.

Aspects of the project sites. Top to bottom: Lower Manhattan, Liberty State Park, and the Bayonne, New Jersey, waterfront.

Rising sea level and more frequent and violent storms, the combined effects of global warming, are predicted to create anything from a normative 2-foot rise in the harbor and estuaries of New York City by 2080 to surges of up to 30 feet in a Category 1 storm. *Rising Currents: Projects for New York's Waterfront*—a workshop, an exhibition, and now a book—reimagines the city in light of the future effects of climate change, exploring development now to meet future conditions.

In autumn and winter 2009–10, MoMA PS1, in Long Island City, Queens, hosted five design teams, each an interdisciplinary mix of expertise in architecture, landscape architecture, engineering, ecology, and visual art.[1] Each team was assigned a location in and around New York City and tasked with developing so-called "soft infrastructure" there, proposals that would ameliorate the effects of climate change by mimicking nature and accepting a blurring of the edge between land and water. Over the course of two and half months, expert advisors and the general public were invited to MoMA PS1 to view and comment on the designs in progress. The teams contributed to a *Rising Currents* website and blog throughout the period, and the project culminated with an exhibition of their work in The Robert B. Menschel Architecture and Design Gallery at The Museum of Modern Art, in March 2010. Even before the projects were completed and installed, the workshop had catalyzed a public and professional following and considerable discussion in the media.

THE MUSEUM

One of my goals upon joining MoMA in 2007 was to find innovative ways to engage with contemporary practice in architecture, landscape architecture, city planning, and design-related engineering, complements to what I call the "reactive" curatorial mode. In the reactive mode, the curator culls from recent or ongoing production what he or she admires and thinks deserves contextualization and wider publicity. It is the traditional role of the curator, developed along with the role of the museum as a showcase for architecture retrospectives.

Now, with the availability at the Museum of MoMA PS1 as a kind of research tank and of the Internet as a way of communicating with the public on an ongoing basis, another approach is possible. There are many issues MoMA could engage more actively and productively, whether identifying and supporting trends in current design or posing questions that have not yet been adequately addressed, be they social, technical, or environmental. In this way, the Museum would not simply research and reflect the production of architecture but would be part of its larger societal role and an actor in the culture of design. This curatorial mode is not completely foreign to MoMA. Since its founding in 1932, the Museum's Department of Architecture (since 1949 the Department of Architecture and Design) has been associated with strong positions and polemical campaigns for change. *Modern Architecture: International Exhibition* (1932) did not simply expose American audiences to the most recent progressive architectural design in Europe; it is too often forgotten that this influential exhibition included a critique of current housing conditions in New York—a critique that in subsequent years the great urban theorist Lewis Mumford and the pioneering housing scholar and advocate Catherine Bauer helped to perfect in exhibitions (notably *Housing Exhibition of the City of New York,* at MoMA in 1934) that led to changes in public policy at both municipal and federal levels.[2] In the late 1960s, the department again engaged the pressing needs of the city, inviting four university-based teams of architects to create counterproposals for four areas of Manhattan and the nearby Bronx slated for massive redevelopment. The resulting exhibition, *The New City: Architecture and Urban Renewal* (1967), sparked a debate in the press and, to a limited extent, among the public.[3] In that episodic tradition, *Home Delivery: Fabricating the Modern Dwelling* (2008) brought reactive and activist curatorial modes together, the latter represented by a series of full-scale, newly commissioned proposals for prefabricated housing, installed on the Museum's vacant lot on West Fifty-third Street in Manhattan, as well as samples of digitally fabricated walls in the introductory gallery of the historical exhibition indoors.[4] The aim was not simply to showcase existing work but also to focus the current excitement about digital fabrication on an issue that has long both fascinated and frustrated modern architects—the serial fabrication of dwellings—engaging both hard technology and computer-guided software to create a new paradigm for the delivery of architecture. In both *Home Delivery* and *Rising Currents* the curatorial teams brought together players who do not frequently collaborate, hoping to stimulate a new interchange—between researchers in prefabrication and digital fabrication, in the former, and between architects, landscape architects, engineers, ecologists, and artists in *Rising Currents*.[5]

Views of *Modern Architecture: International Exhibition*, 1932 (top), and *The New City: Architecture and Urban Renewal*, 1967 (bottom), at The Museum of Modern Art, New York.

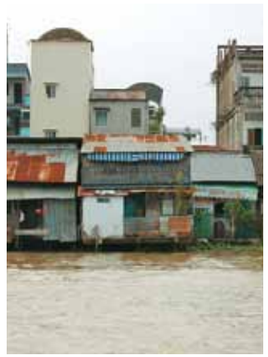
Outdoor and indoor sections of *Home Delivery: Fabricating the Modern Dwelling*, 2008, at The Museum of Modern Art, New York.

THE PROBLEM

Sea level rise is underway around the globe, as oceans warm and glaciers melt. Its seriousness is rendered dramatically clear by the quest—much covered in the press in the last few years—of the Maldives to find a new home for its population of almost 400,000, since the atolls that support the Indian Ocean nation reach their peak at around 8 feet (2.5 m). Rising water levels will change not only the contours of islands but also population patterns around the world, as millions of people in heavily populated areas are directly affected. Ten of the world's fifteen largest cities are in low-lying coastal areas vulnerable to rising sea level or coastal surges, including Shanghai, Mumbai, and Cairo. In the Mekong Delta, home to some 17 million people, more than one-third of the land area will be underwater if government reports are correct. They predict a sea level rise

in the Gulf of Thailand of as much as 3 feet (almost 1 m) within the next few decades. The most conservative estimates predict that at least one-fifth of the delta will be inundated.[6] Rapid climate change is overwhelming the arrangements that, in the past, allowed countries to cope with floods and storm surges. Today the Netherlands spends around $100 per person per year on flood defenses; in Bangladesh, a country prone to dangerous flooding, that sum is one-quarter of the average annual income for an individual.[7] The opening up of year-round ice-free channels in the Arctic, as glaciers melt, is changing patterns of trade, creating potential new geopolitical rivalries, and displacing populations—and not only of endangered polar bears.

Recent efforts to heighten public awareness of these facts and to engage the design community have extended from science museums and academic conferences to the studios of architecture schools. The Norwegian National Museum of Science, Technology, and Medicine in Oslo recently presented *Klima X* (Climate X, 2007–09), an exhibition in which visitors donned rubber boots to negotiate a flooded room containing melting blocks of ice symbolizing the Arctic ice cap.[8] In 2009 the National Gallery of Modern Art, Mumbai, presented the exhibition *Soak: Mumbai in an Estuary,* a study by Anuradha Mathur and Dilip da Cunha about adapting the city to increasingly frequent inundation—a project they also presented as a workshop and studio at the University of Pennsylvania.[9] I was determined that in New York, in a country where far too many resources are spent trying to deny the phenomenon of climate change rather than address it, the Museum would provide a similar platform for broad public debate. This seemed particularly important in light of the new and prominent national discussion, after the financial crisis of autumn 2008, about the role of the federal government in investing in infrastructure. Between 2008 and 2010 the federal government made a massive investment in infrastructure projects in the form of a $787 billion stimulus package, intending to address urgent needs in transportation, flood protection, and coastal management, all the while putting unemployed citizens back to work. This approach has since been criticized from all points on the political spectrum, from those who, like economist and *New York Times* columnist Paul Krugman, argue that the amount was too small and the investment too dispersed, to those who argue for budgetary austerity rather than neo-Keynesian stimulus. The package was a noble effort, but it embodied inherent conflicts and paradoxes. Not least is the typical atomization of projects by congressional district and the urgency to begin construction immediately; the latter requirement necessarily shortchanged the study of new solutions to vital problems—study that predictions of unprecedented climate change make imperative. "Shovel ready" and innovation simply do not conjugate easily and certainly not in the future conditional, which was the favored verb tense of the *Rising Currents* workshop and exhibition.



Tidal flooding encroaches on shops and homes in Can Tho, Vietnam, November 2008.

FEBRUARY 9, 2010

The *Rising Currents* proposals tell us that we may need to think in a completely different way about infrastructure, parks, how we live and get around, and the intersection of water and land in the cities of the twenty-first century.

—Adrian Benepe, Commissioner, New York City Department of Parks and Recreation, on the *Rising Currents* blog

Barry Bergdoll introduces the *Rising Currents* project to visitors (top), and visitors view work in progress by teams led by LTL Architects (middle) and Matthew Baird Architects (bottom), at the *Rising Currents* open house at MoMA PS1, December 12, 2009.

THE WORKSHOP

The five sites explored in *Rising Currents* are roughly equivalent to those delineated as test cases in *On the Water: Palisade Bay,* the 2007–09 study by Guy Nordenson, Catherine Seavitt, and Adam Yarinsky. *On the Water* is fundamental to our project. Catalyzed by predictions of rising sea level and other effects of climate change, it is at once a historical account of the transformation of the New York–New Jersey Upper Bay from one of the world's great natural harbors into one of its most elaborately reconfigured man-made ports, and a manual for interventions on its coastlines that would both ameliorate the effects of climate change and make the water, once again, the focal point of the city. In addition, it is an appeal to augment the usual toolbox of so-called "hard infrastructure" solutions (such as the concrete seawalls and storm barriers preferred by the US Army Corps of Engineers) with a whole range of soft infrastructure solutions—artificial islands, wind farms, oyster beds, absorptive wetlands (including berms and sunken capture areas)—and the possibility of simply allowing some areas to submerge under an occasional *acqua alta,* as in Venice: "Despite our best efforts," climate-change scientist Michael Oppenheimer declares in the preface to the study, "the city and the water remain one organism. As the sea rises and the storms intensify, the water will break down the boundary again and again. The question is whether we should build faster and harder to keep it out, or find a way to gently merge ourselves with the water once again, transforming the hard boundary into a continuum, a smooth transition, a commingling rather than a battle zone."[10]

Eager to extend this provocative question through the frame of the Museum, in 2008 I began discussing with Nordenson how *On the Water* might become an exhibition.[11] We considered asking some of the most successful Dutch designers to come to New Amsterdam to respond to the proposals in *On the Water,* maybe even in conjunction with the quatercentenary of the Hudson River, which for a season focused attention on the vital relationship of the city to its great river and harbor. In September of that year, during the previews of the 11th International Architecture Exhibition at the Venice Biennale, violent storms and high water in Venice were accompanied by the unfolding drama in the newspapers of the collapse of Lehman Brothers in New York and the turmoil it was unleashing in the world financial markets. By the end of the year, layoffs in New York architecture firms had reached alarming levels. From this set of challenging circumstances the idea of an exhibition on Nordenson, Seavitt, and Yarinsky's study began to take on new dimensions. Our conversation turned to the idea of a workshop, and to the formulation of twin goals: reconceiving rising sea level and increasing storm surges from enemies to be combated into new conditions to be designed for—from problems to opportunities—and tapping the generation of architects and designers, poised to make significant contributions, that might be lost to the profession at a moment when so many offices were experiencing a sudden loss of commissions.

In September 2009, with the support of a substantial grant from The Rockefeller Foundation, we invited some sixty educators and leading practitioners in architecture, landscape architecture, and engineering from around the country to nominate emerging design talents for a workshop based on *On the Water*'s challenges and recommendations. Nominees were to assemble teams from their offices and from the larger pool of talent available in the recession. In October, ten finalist teams were interviewed and four were selected to take up residence at MoMA PS1; their leaders are recently established practitioners, most of whom divide their time between a small-to-medium-sized office and a university school of architecture. They were joined by a team headed by Yarinsky and Stephen Cassell of Architecture Research Office (ARO) in partnership with Susannah C. Drake of dlandstudio. ARO had worked on a proposal for *On the Water,* and the firm was invited to continue and expand the work. During an intense eight weeks, punctuated by

weekly reviews by me, Nordenson, Seavitt, and numerous guests, the teams—some thirty people in all—worked in a marvelous spirit of cooperation and exchange. A self-published version of *On the Water* was made available to them, while MoMA teamed up with Hatje Cantz and the Princeton University School of Architecture (all three authors teach at the university) to republish the book in time for the opening of the exhibition at MoMA.[12] Its valuable compilation and analysis of historical cartography and the hydraulic, topographic, and bathymetric features of the New York–New Jersey Upper Bay allowed the teams to grasp quickly the characteristics of their sites and turn almost immediately to design solutions.

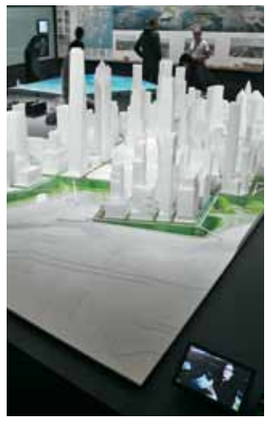
Visitors also provided important preliminary information to the teams, notably those from the Marine Sciences Research Center at the State University of New York at Stony Brook. Six years ago, scientists at the center proposed the construction of three flood-gates for New York City—in the Narrows between Brooklyn and Staten Island, at the upper end of the East River, and in the tidal strait between New Jersey and Staten Island—a technique modeled on the Delta Works in the Netherlands and the Thames Barrier in London, both of which can be put into action to protect cities from coastal flooding. Stony Brook University has some of the most sophisticated equipment for the as-yet-imperfect science of modeling storm surges, so the scientists were able to offer the teams invaluable advice on the viability of various scenarios and design solutions. Other visitors followed in successive weeks. Some, actively involved in planning and environmental advocacy in the New York region, were invited to share their expertise or engage in conversation. Others who learned of the project asked to become involved. Amanda Burden, chair of New York's City Planning Commission and director of the Department of City Planning; Tom Wright, executive director of the Regional Plan Association; and Nordenson all gave public presentations as an orientation to the project. Observers and critics from the Port Authority of New York and New Jersey, the New York State Sea Level Rise Task Force, the New York State Department of Environmental Conservation Office of Environmental Justice, the Governors Island Preservation and Education Corporation, the New York City Mayor's Office of Long-Term Planning and Sustainability, the City Planning and Parks and Recreation departments, and the Hudson-Fulton-Champlain Quadricentennial Commission visited, responding to the teams' evolving work and absorbing the potency of the new techniques being explored. We held two open houses, in December 2009 and January 2010, to which the general public was invited to discuss the workshop's goals and hear about the work in progress.

LEFT: Visitors view work in progress by the team led by Kate Orff, of SCAPE, at the *Rising Currents* open house, December 12, 2009.

OPPOSITE: The *Rising Currents* exhibition at The Museum of Modern Art, New York, 2010.

ABOVE: New Urban Ground.

BELOW: Model for New Urban Ground in the *Rising Currents* exhibition.



The teams based their work on the projections of climate-change effects summarized in *On the Water* and did not temper their visions by responding to existing real estate interests or current land-use regulations. They worked in collaborative interchange but were not charged with making a master plan; the aim was not to create a planning document for New York City—one that might easily enter the annals of unrealized urban plans—but rather to produce designs rich in attractive ideas that could be used elsewhere in the region or adapted to other cities around the world. I repeatedly reminded the teams of the task at hand: "Your mission is to come up with images that are so compelling they can't be forgotten and so realistic they can't be dismissed."

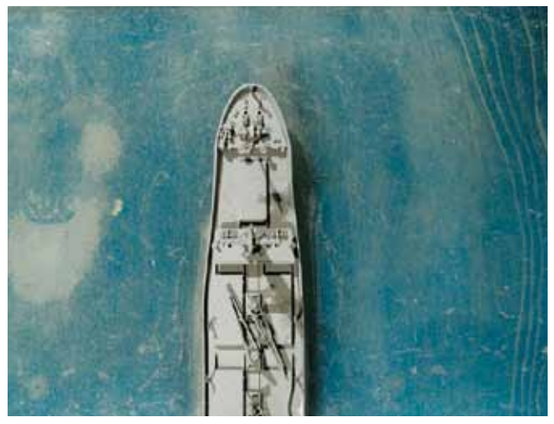
The proposal for Lower Manhattan by the team led by Cassell and Yarinsky of ARO and Drake of dlandstudio is typical of all the *Rising Currents* projects in being site specific while containing many ideas with far wider applicability. Drake had conceived a landscape of absorptive material for the highly polluted Gowanus Canal (declared a US Environmental Protection Agency Superfund site while the workshop was underway) in a 2008 project called Sponge Park, and the team's project for *Rising Currents,* New Urban Ground, extends that concept into a comprehensive rethinking of the texture of the coastline and the urban street.[13] Transformed through new wetlands, the coast is a complex natural instrument for filtering both tidal change and street runoff after storms, and the streets themselves are "greened" through surfacing in absorptive, open-mesh concrete tiles and a layered filtering system.

ABOVE: Site plan for Working Waterline with inset animation stills and model sections, as it appeared in the *Rising Currents* exhibition.

BELOW: Details of models for Working Waterline showing a cluster of glass reef components and shipping routes.

OVERLEAF: Visitors at the *Rising Currents* exhibition.

Leading a team of young architects, ecologists, and a landscape designer—plus artist consultants Mark Dion and Matthew Ritchie—Matthew Baird of Matthew Baird Architects tackled a site that includes an oil tank farm in Bayonne, New Jersey. As polluted land, it must be protected from flooding as sea level rises. A large berm is the last defense in a series of interventions proposed by the team, which includes recycled-glass "jacks" distributed in shallow coastal waters to attenuate waves, particularly during storm surges. The berm and these aquatic reefs create new recreational opportunities but do not entirely transform the site's industrial character: the oil tanks are converted into a biofuel facility, and World War II–era piers and warehouses support a recycling operation. With the melting of ice in the Arctic, shipping routes have been opened in the last few years that will undoubtedly reshape the maritime economy of the New York/New Jersey harbor; the team's proposal envisions new natural and economic ecologies for the region.



The group led by Kate Orff of SCAPE proposes a massive project of wildlife restoration. New York's waters, as Mark Kurlansky has demonstrated in his recent popular ecological history *The Big Oyster: History on the Half Shell*, were once home to numerous oyster beds, and oysters were a major part of the city's diet and economy as well as the harbor's ecology.[14] Orff's team proposes to transform the Gowanus Canal from one of the country's most polluted waterways into one of its most productive oyster hatcheries. The canal has many properties that make it an ideal site for oyster cultivation, Orff argues, and the mollusks, in turn, assist in cleaning the water. Once they are hatched, the oysters are relocated to the Bay Ridge Flats, south of Governors Island, where they create a wave-attenuating reef and a new natural aquatic park, protect the adjacent shoreline, and stimulate the growth of other marine life. Planning here is not simply static design but the implementation and exploitation of dynamic natural systems.

OPPOSITE: Rendering of Oyster-tecture in the *Rising Currents* exhibition (top) with model of oyster reef (bottom).

TOP: Detail of New Aqueous City showing man-made islands connected by barriers that inflate in the event of storm-surge flooding.

BOTTOM: New Aqueous City installation in the *Rising Currents* exhibition.

The proposal by the team led by Eric Bunge and Mimi Hoang of nARCHITECTS introduces a network of artificial islands into the harbor, just north of the Verrazano-Narrows Bridge, the nodal points in a system of submerged inflatable barriers that will minimize storm surges. This is not a new technology; but here it is deployed as a component of the team's vision of a "new aqueous city"—a form of urbanism in which the city extends into the water, and water enters the city. An ever-growing population is accommodated by aqueous neighborhoods featuring suspended housing, wave-attenuating piers, and service by a new generation of biogas ferries and a tramway. Land neighborhoods are punctuated by basins and culverts that absorb storm runoff and function as parks in dry weather.

The team led by Paul Lewis, Marc Tsurumaki, and David J. Lewis of LTL Architects created some of the most beautiful images to result from the workshop. Their low-lying site—Liberty State Park—is man-made; it did not exist 150 years ago, and if no intervention is made it will not exist in large measure a century from now. The team stepped back in time to imagine the harbor as a place of blurred lines between land and sea.[15] They propose to cut into the existing landfill and redeploy it to achieve a varied topography on the flat site, a crenellated landscape of jagged fingers that, by lengthening the coastline manyfold, allows it to attenuate waves and serve as a natural filter of tidewater. The new topography is zoned for a range of urban functions, from leisure and recreation to aquaculture and commerce, all placed on the site in relationship to the degree of protection the elevation offers from flooding.

The five projects are highly individual—indeed, one of our goals was to encourage an artistic signature in infrastructure design—but they share a number of features, which in sum illustrate the lessons of *Rising Currents.* Throughout the proposals, the benefits of a more varied seafloor are espoused, in artificial and natural reefs and islands built of materials ranging from recycled glass to oysters to conventional landfill. They embrace a natural transition between water and land, introducing absorptive wetlands both to ameliorate changes in sea level and support recreational facilities and restored natural habitats, and they propose flexible forms of interpenetration of water and land, extending the city into the sea, and the sea into the city. Nature itself is incorporated into the

TOP: Detail of Water Proving Ground showing an amphitheater adjacent to Liberty Island that operates as a venue for outdoor concerts.

BOTTOM: Detail of projection model for Water Proving Ground showing predicted storm-surge flooding.

OVERLEAF: Project models and site plans in the *Rising Currents* exhibition.

design vocabulary of architecture, a trend that has been growing in recent years with the rapprochement between architecture and landscape design—a blurring of professional boundaries parallel to the continuity proposed in *On the Water* and *Rising Currents* between topography and bathymetry, land and sea.

The workshop's experimental approach to design was paralleled in the planning of the exhibition. In review and critique sessions during the weeks leading up to the show, comments on the projects by me, Nordenson, and Seavitt (who were actively engaged as critics) moved seamlessly into discussions of graphic and modeled depictions of their components and the strategy for exhibition. The installation design was the collective work of the teams, of me as curator, and of MoMA exhibition designer and production manager Lana Hum and exhibition graphic designer Hsien-yin Ingrid Chou. Rarely in exhibition preparation are the designers of the installation and the graphic scheme involved in conversations during the making of the work itself, but in our process they were key participants. A dedicated website within MoMA.org was developed for the project, and during the workshop the teams and many of the visiting critics posted regular process and progress reports, reactions, and impressions.

When the exhibition had been up for several weeks, we realized how catalytic the whole experiment had been. The gallery was continually filled with visitors engaged in reading the wall texts, studying the designs, and taking in the experience of the architecture pinup through video interviews with the team leaders. During the show the website hosted a series of guest editorials about the project by observers from outside the process: Adrian Benepe, commissioner of the New York City Department of Parks and Recreation; Leslie Koch, executive director of the Governors Island Preservation and Education Corporation; Adriaan Geuze, an architect developing a park on Governors Island; and many others. The site was an ongoing forum for reactions, responses, and dialogue among members of the general public, visiting architects, and Museum visitors in the galleries, where two computers were provided for access.

Continual invitations to me, to Nordenson, and to team members to lecture on *Rising Currents,* even after the exhibition had closed, convinced us that it would be desirable to publish the projects, making them available to designers and students embarking on workshops on related themes and public officials planning for more resilient cities. It is our sincere hope that these projects will continue to contribute to a discussion of the role design has to play in meeting the challenges posed by climate change. We also hope that these five projects will be launching pads for other studies, studios in architecture schools, workshops in city planning offices, and debates in which public policy and design will interact in productive ways. Both the workshop and the exhibition are responses to the very real challenges delineated in *On the Water*. Their successes in generating new design ideas and new conversations are reasons to believe that New York and other cities around the world can transform themselves in productive, positive ways—for land, sea, and citizens alike—in response to environmental challenges larger, perhaps, than any faced before.

FEBRUARY 9, 2010

From the Parks point of view, the proposals represent some innovative ways to create new realms of public space, places that are not traditional parks, but rather are flexible zones of water and land and plants and animals. We currently tend to look at parks as distinct from other urban forms, with fences, walls, planted buffers—different vocabularies of building materials. While each team has proposed concepts very different from the others, they all redefine the interaction of streets, parks, seawalls, canals, piers, and even the harbor itself.

—Adrian Benepe, Commissioner, New York City Department of Parks and Recreation, on the *Rising Currents* blog

FEBRUARY 17, 2010

The work of the five teams at P.S.1 illustrates that climate change will require us to alter the way we behave as individuals, build and operate infrastructure, design buildings, utilize land, manage natural resources, make investments, and plan for the future. Their work emphasizes innovative strategies that enhance our built environment while embracing the natural environment—even as it changes around us.

—Adam Freed, Deputy Director, Mayor's Office of Long-Term Planning and Sustainability, New York, on the *Rising Currents* blog


EXIT
WORKING WATERLINE

NOTES

1. The venue was made available through the program Free Space, an ongoing collaboration between MoMA PS1, artists, and nonprofit arts institutions initiated in 2009. Participating artists and groups are invited to use MoMA PS1's gallery space for research and development in exchange for a public performance, event, or exhibition. The goal of the program is to support the New York arts community during the economic downturn.
2. *Modern Architecture: International Exhibition,* organized by Henry-Russell Hitchcock and Philip Johnson, was on view at The Museum of Modern Art, New York, February 9–March 23, 1932. *Housing Exhibition of the City of New York*, organized by G. Lyman Paine, Jr., was on view at MoMA October 15–November 7, 1934. On the 1932 exhibition, see Terence Riley, *The International Style: Exhibition 15 and the Museum of Modern Art* (New York: Rizzoli and Columbia Books on Architecture, 1992).
3. *The New City: Architecture and Urban Renewal*, organized by Arthur Drexler, was on view at The Museum of Modern Art, New York, January 24–March 13, 1967. See Elizabeth Kassler, Sidney J. Frigand, and Arthur Drexler, *The New City: Architecture and Urban Renewal* (New York: The Museum of Modern Art, 1967).
4. *Home Delivery: Fabricating the Modern Dwelling,* organized by Barry Bergdoll and Peter Christensen, was on view at The Museum of Modern Art, New York, July 20–October 20, 2008. See Bergdoll and Christensen, *Home Delivery: Fabricating the Modern Dwelling* (New York: The Museum of Modern Art, 2008).
5. For more information about this and other aspects of *Home Delivery,* see Bergdoll, "Plein-air Prefab," *The Skira Yearbook of World Architecture, 2007–2008* (Milan: Skira, 2008), 88–89.
6. Seth Mydans, "Vietnam Finds Itself Vulnerable if Sea Rises," *New York Times*, September 24, 2009, http://www.nytimes.com/2009/09/24/world/asia/24delta.html.
7. "Developing Countries and Global Warming: A Bad Climate for Development," *The Economist*, September 17, 2009, http://www.economist.com/node/14447171.
8. *Klima X*, a collaboration among the host museum, The International Polar Year (IPY), the Centre for International Climate and Environmental Research, Oslo (CICERO), The Norwegian University of Science and Technology (NTNU), Trondheim, The Norwegian Meteorological Institute (DNMI), The University Centre of Svalbard (UNIS), The University of Oslo (UoO), Statistics Norway (SSB), World Wide Fund for Nature (WWF), Bellona Foundation, Institute for Energy Technology (IFE), and The Norwegian Oil Industry Association (OLF), was on view at the Norwegian National Museum of Science, Technology, and Medicine, Oslo, 2007–09.
9. *Soak: Mumbai in an Estuary*, organized by Anuradha Mathur and Dilip da Cunha, was on view at the National Gallery of Modern Art, Mumbai, June 23–August 23, 2009. See Mathur and da Cunha, *Soak: Mumbai in an Estuary* (Calcutta: Rupa Co., 2009).
10. Michael Oppenheimer, preface to Guy Nordenson, Catherine Seavitt, and Adam Yarinsky, *On the Water: Palisade Bay* (New York: The Museum of Modern Art, 2010), 10.
11. For more information on the process, see Bergdoll, afterword to Nordenson et al., *On the Water*, 301–303.
12. This is Nordenson et al., *On the Water*. See note 9.
13. For more information about Sponge Park see the project website, at http://www.spongepark.org/.
14. Mark Kurlansky, *The Big Oyster: History on the Half Shell* (New York: Ballantine Books, 2006).
15. The island of Manhattan as Henry Hudson found it in 1609 is brought vividly to life by Eric W. Sanderson in *Mannahatta: A Natural History of New York City* (New York: Abrams, 2009).

CLIMATE CHANGE AND WORLD CITIES

Michael Oppenheimer

Cities—those vibrant multicultural platforms for interaction, industry, and ingenuity, where the worst and best humanity has to offer are often on display in close proximity—are caught in a pincer. A seemingly inexorable emigration of people from rural to urban areas is accelerating. Urban population around the globe is projected to grow by 1.6 billion by 2030 (due to migration and births), while the rural population shrinks by 28 million.[1] In China alone, about forty thousand people per day make the trek from country to city, and most will never return.[2] However, just as the total population of cities and towns exceeds that of rural areas for the first time in human history, cities face a new threat: climate change.

Our atmosphere is transparent to the sunlight that provides almost all the heat available at Earth's surface. As the surface warms, it radiates heat back into space. But the atmosphere contains heat-trapping "greenhouse" gases, such as carbon dioxide and water vapor, which act like a blanket, absorbing some of the outgoing heat, warming the surface further, and establishing the equable climate that nurtures life as we know it. Unfortunately, humans are upsetting this long-established balancing act. We draw our energy for electric power plants, cars, and factories largely from the combustion of fossil fuels: coal, oil, and natural gas. The carbon dioxide and other gases emitted in the process are thickening the atmospheric blanket. Earth is experiencing a global warming.

This much is fact. Data from a network of thermometers, supplemented by recent satellite measurements, has produced a reliable 150-year record that reveals a spatial pattern of warming bearing the unique signature of the greenhouse effect.[3] Simultaneously, sea level is rising for two reasons: the warming of the ocean is measurable down to thousands of feet, and ocean water, like any fluid, expands when it is heated; and mountaintops and polar lands are covered with ice, which is warming as well. What does ice do when it warms? It eventually melts. Where does that meltwater go? Eventually, it flows into the ocean, further raising the sea level. Earth has warmed by about 1.4 degrees Fahrenheit (0.8°C) over the 150-year period of measurement. Additional warming is inevitable because the oceans are so big that they warm up slowly, lagging behind the temperature dictated by gases already emitted. Sea level has already risen about 7 inches (15–20 cm). Projections of sea level rise over this century depend on how much additional gas we emit before reining in the problem. Estimates run as high as 3 feet (about 1 m) or more (enough to permanently inundate a 300-foot width of Atlantic coast beach) but are very uncertain due to our inability to accurately predict the response of the polar ice sheets to warming.[4] In addition, coastal storms episodically drive the ocean inland, temporarily flooding large areas of land and then withdrawing again. In the

future, storms of the same intensity as today's will be pushing a sea that starts out at a higher level. As a result, water will reach further inland, flooding larger areas. Abandonment of episodically flooded lands could occur long before permanent inundation.

Most of humanity lives near or at a coast, and many people are clustered in cities. A virtue of cities is that they can accommodate large numbers of residents in close proximity to resources, such as harbors, where they can work efficiently, moving goods and services around the world. But cities accomplish this task by taming the coastline, replacing beach and wetland with cement and building right up to the edge of the water. Scientists have studied forty large river deltas, and most are a functional hodgepodge of agricultural land enriched by fluvial sediment, densely concentrated populations, and megacities with expensive infrastructure, a high level of economic activity, and an uneven distribution of wealth. About five hundred million of us live on those deltas, in cities including New Orleans, Amsterdam, Dacca, and Shanghai.[5] But that's not the end of the story. Add to this number the hundreds of millions living in other urbanized coastal zones, not situated on deltas but still at sea level in the tidal zone, like New York, Miami, Washington, D.C., London, Sydney, Bangkok, and Mumbai.

That their relatively inflexible infrastructure makes them particularly vulnerable to sea level rise is but one of several characteristics unique to urban areas that have become problematic in a warming world. Most notable is the phenomenon of the urban heat island. The high density of energy-generating activities, a preponderance of dark surfaces (which absorb heat readily), concrete (which releases the heat of the day only slowly at night), and paving (which shuts off natural sources of moisture whose evaporation would moderate high temperature) are among the factors keeping urban temperatures elevated above those of the surrounding countryside, particularly at night. As areas of the Middle East and Southwest Asia urbanize over this century, nighttime urban temperatures in those regions could increase by as much as 10 degrees Fahrenheit (6°C) over surrounding rural areas.[6]

In North America and Europe, urbanization may have largely run its course, but global warming will further raise temperatures in urban heat islands. It is well-known from studies of mortality rates in heat waves that high nighttime temperatures are particularly deadly, because it is at night that the body's metabolism recovers from the stresses of the day. Even a short string of nights in which temperatures stay above 80 degrees Fahrenheit (27°C) can be highly problematic. Deadly heat waves are fairly common in tropical developing countries like India. But even highly developed northern countries are not immune. Approximately forty thousand deaths across Western Europe were attributed to the direct and indirect effects of a suffocating heat wave that struck in August 2003. That heat wave was a once-in-a-thousand-years event: that is, in any one year, it had about a 0.1 percent chance of occurring. But computer models that project global climate change show that greenhouse gas buildup could make such events yearly occurrences by the end of this century. The risk of heat-related deaths would be compounded in urban heat islands.[7]

Freshwater flooding, resulting from heavy rainstorms, is another issue for urban areas. Global warming makes the atmosphere wetter overall, because as the surface of the sea warms, the evaporation of water into the atmosphere increases. What goes up must come down, and in the case of this extra water vapor it comes down mostly at times when rain would occur anyway. In other words, the extra water makes existing rainstorms yet more intense. In the northeastern United States, storms delivering over 2 inches (5 cm) of precipitation in twenty-four hours are relatively rare, occurring only a few times per year. But the frequency of such events has increased over the past century, and the aforementioned computer models project an even greater increase in the coming decades. Here again, the rigid structure of cities works against them. Under natural circumstances, water is absorbed and drained away by soil and vegetation, which moderates the potential for damaging floods. But urban areas have largely been paved over, and water can't drain away harmlessly. Instead, it seeks low points on the surface, like a dip in the pavement under a highway overpass or the basement of a house. The result is costly damage and sometimes loss of life.

An emerging area of interest is the connection between global warming and human migration. Case studies from Burkina Faso, Nepal, Mexico, and the United States (including the Dust Bowl) demonstrate that people often move when climate conditions become unfavorable to agriculture.[8] All other things being equal, under unfavorable climatic conditions a farmer in Mexico might decide that prospects look brighter across the border. But once the farmer emigrates, he is unlikely to take up farming. More likely, he will move to a city and pursue other options. So an indirect consequence of global warming may be an acceleration of the trend toward urbanization already underway.

Let's step back and consider the picture we have painted. Urban areas are already bursting at the seams as a result of a flow of migrants from rural areas. This is a worldwide phenomenon, and there is no reason to believe it will reverse (although particular circumstances could favor a return flow in specific areas); furthermore, we can expect global warming to accelerate this trend. Urban areas currently accommodate these migrants, for better or worse, and adapt to the flow, although some of these adaptations, like slums, may leave the inhabitants worse off than they were in the situation they left. At the same time, the risks to human well-being from heat waves, sea level rise, episodic storms, and flooding are expected to increase over time, and as more and more people move to urban areas these risks will be compounded.

Even the most forward-looking design can only ameliorate, not solve, the problem, since it is not likely that we will ever be able to predict the future with sufficient accuracy and far enough in advance to completely implement the necessary approaches. And if the climate warms as rapidly as some projections suggest, we won't be able to implement either the old or the newer approaches fast enough to meet the challenge. This brings us to what must be the central element of any effective program to solve the climate problem: reducing the emissions that are causing the warming. Given the rugged road faced by domestic climate legislation and negotiations such as those at the 2009 United Nations Climate Change Conference in Copenhagen, it is fair to ask if there is any realistic prospect for emissions reductions that would make a dent in the warming trend. There are credible opinions on both sides of the question, but some recent developments suggest that we are muddling toward a lower-emissions world.

The United States is often painted as a renegade on emissions-reduction efforts due to its 2001 withdrawal from the Kyoto Protocol global warming treaty, but through a combination of intentional and inadvertent actions it has reduced its total greenhouse gas emissions slightly over the past decade, countering rather than continuing the upward march that has characterized previous decades. The plateauing of emissions was well underway before the 2008 financial crisis struck.[9] Even without comprehensive federal legislation, automotive fuel economy and appliance efficiency standards have been tightened by executive action (both approaches reduce energy use and, therefore, the burning of fossil fuel), states have implemented greenhouse gas emissions limits on electric power plants and other sources, and individual cities (many realizing the looming problems outlined above) have begun to plan farsighted programs to reconfigure new development and, to some extent, renovate existing systems to increase efficiency and reduce overall emissions. ICLEI—Local Governments for Sustainability (formerly the International Council for Local Environmental Initiatives) has aided in this by facilitating pilot projects and providing a vehicle for information sharing.

When the United States dropped out of the Kyoto Protocol, the European Union pressed forward, and its member states are more or less on track to meet their obligations. Of course, such progress was facilitated by the financial crisis dampening energy demand,

6FT

Projected sea-level rise by 2100.

5FT 8IN

Projected sea-level rise with a category 1 storm surge. A storm surge is a short-term high-water level caused by a weather event. A category 3 storm surge is greater than a category 1 storm surge.

4F

Ice Melt
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5FT

but a quick tour around Germany, the Netherlands, and Denmark, among other European countries, shows that wind and solar energy have made a significant dent in the electricity generation market; wind provides about twenty percent of Denmark's electricity and eight percent of Germany's.[10] We have gotten two key advances out of the much-maligned Protocol: a large amount of learning about how to organize to fight global warming, including an emissions-permit trading system (a system that sets a price on pollution, an idea the European Union picked up from the United States before the latter dropped out of the Protocol) as well as some meaningful emissions cuts.

Finally, China has its own ideas about the climate issue and, in contrast to its stance over most of the past twenty years, these go well beyond hoping climate worries will evaporate. China burns so much coal that even though it sits atop about thirteen percent of the global reserves, it imports a significant amount from Australia.[11] Its concern over air pollution has fueled a search for alternatives to coal, and the government envisions an economic advantage from cornering various components of the global clean-energy market (it is now the leader in solar cell and wind turbine production). At the same time, its government and scientists take projections of rising sea level seriously; one especially vulnerable area is China's vast coastal zone, where densely populated urban areas, including Shanghai, sit right by the sea, subject to all the risk and uncertainty noted above. One result of this sense of both threat and opportunity is China's willingness to publicly set a target for its domestic emissions limitation through 2020: a forty to forty-five percent cut per unit of gross domestic product, which it intends to enforce as a key part of an energy policy designed to maintain a rapidly growing domestic economy.[12] This and similar commitments by Brazil and several other developing countries were the most important outcomes of the Copenhagen conference, developments that were maintained at the 2010 United Nations Climate Change Summit in Cancun.

If such efforts to reduce greenhouse gas emissions fall short, the opportunity to avoid a dangerous climate change and corresponding sea level rise would disappear. Then our cities would face an unpleasant, difficult, and calamitous future. And given the inevitability of some further warming even if we cut emissions sharply, plus the uncertainty of predictions about precisely how much change is in the offing, we must plan to adapt to a warmer climate no matter what. One possible response is to pursue what have been the standard approaches: if vulnerable people are at risk of heat-related deaths, then make sure they have access to air-conditioning; if heavy rainstorms threaten more and more flooding, then build more storm sewers and lay more drainpipes; as sea level rises, harden the coast more and more, build more seawalls and storm protection (like the Thames Barrier), pile more sand along it (as the Netherlands is doing). These methods work, at least in part, but they are costly, they often simply displace the problem (a standard strategy for urban areas), and they almost always do severe damage to what's left of the natural environment in the vicinity. Finally, often being literally set in stone, such "hard infrastructure" is dependent on a stable climate and sea level, and these are two options we simply cannot count on any longer.

Putting more thought now into how we want our cities to evolve is a far wiser course than simply doing it the old-fashioned way. Other options are available, and we can see the stirrings of a different future in small-scale experiments taking place in cities around the world. Roofs painted a glistening silvery color reflect sunlight, reducing the impact of warming. Floating houses soften the blow from coastal flooding. Semipermeable hardened surfaces allow water to seep through to the ground instead of channeling it to a low point, creating a flood. And as the projects described in this book demonstrate, there are abundant options for softening the interface between urban land and sea, turning a battle zone into an area of peaceful transition. Implementing the new and the old in a sensible combination, while moving promptly to reduce emissions, will provide our cities with their best chance to thrive.

NOTES

1. United Nations Population Fund, *State of World Population 2007: Unleashing the Potential of Urban Growth,* 2007, http://www.unfpa.org/public/home/publications/pid/408.
2. Guoming Wen, "Cautions on China's Urbanization," Maureen and Mike Mansfield Foundation, January 11, 2005, http://www.mansfieldfdn.org/pubs/pub_pdfs/wen0105_chinaurban.pdf.
3. "IPCC, 2007: Summary for Policymakers," in S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, and H. L. Miller, eds., *Climate Change 2007: Working Group I: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge and New York: Cambridge University Press, 2007), http://www.ipcc.ch/publications_and_data/ar4/wg1/en/spm.html.
4. M. P. Cooper, M. D. Beevers, and M. Oppenheimer, "The Potential Impacts of Sea Level Rise on the Coastal Region of New Jersey, USA," *Climatic Change* 90 (2008): 475–92, doi:10.1007/s10584-008-9422-0.
5. Jason P. Ericson et al., "Effective Sea-Level Rise and Deltas: Causes of Change and Human Dimension Implications," *Global and Planetary Change* 50, no. 1–2 (2006): 63–82, doi:10.1016/j.gloplacha.2005.07.004.
6. Mark P. McCarthy et al., "Climate Change in Cities Due to Global Warming and Urban Effects," *Geophysical Research Letters* 37 (May 8, 2010), L09705, doi:10.1029/2010GL042845.
7. Peter Stott et al., "Human Contribution to the European Heatwave of 2003," *Nature* 432 (December 2, 2004): 610–14, doi:10.1038/nature03089.
8. S. Feng, A. Krueger, M. Oppenheimer, "Linkages Among Climate Change, Crop Yields and Mexico–US Cross-border Migration," *Proceedings of the National Academy of Science* (July 26, 2010), www.pnas.org/cgi/doi/10.1073/pnas.1002632107.
9. *Inventory of United States Greenhouse Gas Emissions and Sinks, 1990–2008,* United States Environmental Protection Agency, 2010, http://www.epa.gov/climatechange/emissions/downloads10/508_Complete_GHG_1990_2008.pdf.
10. Larry Flowers, *Wind Energy Update,* National Renewable Energy Laboratory, 2010, http://www.windpoweringamerica.gov/pdfs/wpa/wpa_update.pdf.
11. E. Rosenthal, "Nations That Debate Coal Use Export It to Feed China's Need," *New York Times,* November 21, 2010, http://www.nytimes.com/2010/11/22/science/earth/22fossil.html.
12. For a summary of China's views on energy, economic growth, and climate change, see *China's National Climate Change Program*, National Development and Reform Commission, People's Republic of China, June 2007, http://www.ccchina.gov.cn/WebSite/CCChina/UpFile/File188.pdf.

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Barry Bergdoll
THE PHILIP JOHNSON CHIEF CURATOR,
DEPARTMENT OF ARCHITECTURE AND DESIGN

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