

LOCALIZING global climate change

ABSTRACT

While 2007 has seen a dramatic popular growth in awareness of global climate change, most people have little understanding of how this will effect them directly. Until people get a direct, tangible sense of global climate change, it will remain someone else's concern.

The purpose of this study was to examine the local urban design impacts of global climate change on a historic coastal peninsular city. The study was conducted in five weeks during spring semester of 2007.

SCOPE

This study is an overview of *just* the urban design impacts of global climate change, *limited* to the immediate confines of the peninsula.

PARTICIPANTS

This study was conducted as a public service to a city municipality.

The study was conducted by a studio from a public land-grant university (the Studio). The studio was comprised of 13 students, 5 undergraduates and 8 graduate students. The studio was taught by an architecture professor and a practicing architect.

A professor/scientist/Ph.D. from the geology department of a different in-state university served as Scientific Advisor for this study.

A panel of scientists, city officials, urban designers, and environmentalists reviewed and gave critical input on the final draft of the work.

DISSEMINATION

This work was exhibited, summer 2007, at a City gallery; the work will be re-exhibited in 2008 in the rotunda of a university library. The summer 2007 exhibition was covered in two local papers. PowerPoint presentations of the work are being delivered locally, most recently to the City's newly formed Green Committee, which is charged with formulating a global climate change policy for the municipality.

SCIENCE

This project relied entirely on the January 2007 report of the International Panel on Climate Change (IPCC Special Report on Emission Scenarios, IPCC 2007:WG1-AR4), with interpretations and amendments by our Scientific Advisor.

We studied the high/low extreme SRES-scenarios, adjusted for factors that were left unaddressed by the IPCC (resulting in two study scenarios: A1FI+ and B1+).

PENINSULA URBAN IMPACT

The two greatest direct impacts on urban design due to global climate change will be sea level rise and increased storm intensity. Significant when taken alone, these two factors have compounding implications in the study area: the watertable will rise with sea level, making the already inadequate stormwater system fail. Consequently, the emphasis of this study focused on ways to stop water intrusion from outside the peninsula while managing the increased severity of precipitation within.

STUDY STRUCTURE—BENCHMARKS

As a way of understanding urban design impact, the Studio set up four orders of magnitude in sea level rise, M1-M4. The principal benchmark of the study, M3, is approximately equal to the street elevation of the historic downtown, a 6-foot sea level rise. This is the point at which the downtown would be regularly inundated unless protective measures are taken and the historic value of the settlement negated.

RECOMMENDATIONS

Although global climate change will have serious practical impacts, the study proposes that these problems be addressed by *also* making positive urban changes: expanding civic space, improving recreational and aesthetic amenities, and looking beyond strictly historical precedent for urban possibility. Specific recommendations include:

>Retention Parks: A series of new water-based parks that retain stormwater and expand civic space.

>Elevated Highway: Raising a cross-town highway to create a large mid-peninsula retention park, increase recreation amenities, lift essential roadways to the regional medical district above flood level, and reconnect neighborhoods north and south of this unpopular roadway.

>Marsh vs. Battery: Nurturing marshlands to handle sea level intrusion up to the +1-foot mark; then constructing a battery that would ring the peninsula in urban space, a "Green Necklace."

>Canal City vs. Levee: The study examines the consequences of regional vs. peninsular preservation, and the steps necessary to both. It shows potential design approaches, but refrains from making recommendations beyond M2.

CONCLUSION

The study alerts us to the primary issues of concern (the mutually exacerbating problems of sea level rise and increased storm precipitation), but it also proposes opportunities for improving the public realm in addressing these issues.

LOCALIZING GLOBAL CLIMATE CHANGE

PURPOSE

The awareness of global climate change is changing. In early 2007 when this study was conducted, popular awareness was almost non-existent. Then and now, people have little sense of how and when global climate change will impact them *locally*. Until people get a direct, tangible sense of global climate change, it will remain someone else's concern.

Furthermore, while design professionals are now committed to making the building envelope carbon neutral and, while mass-transit and bicycling are understood to be preferable to oil-burning vehicles, there remains little understanding of how to respond to the threat of global climate change in terms of urban design.

The purpose of this study was to make the threat of global climate change tangible at a local scale to design professionals, city planners, and the general public.

SCOPE

This study is an overview of *just* the urban design impacts of global climate change, limited to the immediate confines of a historic coastal peninsular city. (Where the study expands beyond the peninsula, it is only to address a peninsular urban design problem. Admittedly, the scope of the study is tightly confined.)

SCHEDULE

The study was conducted in five weeks during spring semester of 2007.

DISSEMINATION

Exhibition

An exhibition of this work was mounted during summer 2007 at a City gallery; the work will be re-exhibited in 2008 in the rotunda of a university library.

Press

The summer 2007 exhibition was covered in two local papers.

Lectures

PowerPoint presentations of the work are being delivered locally, most recently to the City's newly formed Green Committee, which is charged with formulating a global climate change policy for the municipality.

PARTICIPANTS

Client

This study was conducted as a free public service to a city municipality. City staff from the planning and sustainability departments had input.

School

The study was conducted by a studio from a public land-grant university (hereafter, the Studio).

Professor + Professional

The studio was taught by an architecture professor in collaboration with a practicing architect.

Students

The studio was comprised of 13 students, 5 undergraduates and 8 graduate students. One student was a landscape architecture major; the rest majored in architecture.

Scientific Advisor

A professor/scientist/Ph.D. from the geology department of a different in-state university served as scientific advisor for this study. His work and expertise are centered in global climate change and he is a recognized regional expert.

Review Panel

A panel of scientists, city officials, environmentalists, and urban designers reviewed and gave critical input on the final draft of the work.

SCIENCE

This project relied entirely on the January 2007 report of the International Panel on Climate Change (IPCC Special Report on Emission Scenarios, IPCC 2007:WG1-AR4), with interpretations and amendments by our Scientific Advisor. An overview of our scientific assumptions that structured or impacted our study follows.

Emission Scenarios

The IPCC developed four Emission Scenarios for predicting future climate change, using two major variables: ecological vs. economic priority, and global vs. localized geo/political organization.

A/B SCENARIOS

The A-series scenarios model a value system that puts economic growth ahead of other concerns; the B-series scenarios model a world in which environmental values trump economic ones. Both are more ecologically-oriented than global values at the time of the study.

1/2 SCENARIOS

The 1-series scenarios look at global population organizations and the 2-series at more isolated local organizations.

A1: The A1 scenario describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1 scenario family develops three alternative directions of technological energy change. The three A1 groups are distinguished by their technological emphasis: fossil-intensive (A1FI), non-fossil energy sources (A1T), and a balance across all sources (A1B).

A2: The A2 scenario describes a heterogeneous world of self-reliance and preservation of local identities. Fertility patterns across regions converge slowly, which results in continuously increasing population. Economic development is regionally oriented and per capita economic growth and technological change more fragmented and slower than other storylines.

B1: The B1 scenario describes a convergent world with the same global population as the A1 storyline, service and information economic structures being dominant, and reductions in material intensity along with the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social and environmental sustainability, including improved equity, but without additional climate initiatives.

B2: The B2 scenario describes a world in which local solutions to economic, social, and environmental sustainability dominate. It is a world with continuously increasing global population, at a rate lower than A2, intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 storylines. While the scenario is also oriented towards environmental protection and social equity, it focuses on local and regional levels.

In all, IPCC looks at six scenario groups: A1B, A1FI, A1T, A2, B1 and B2. All are considered equally probable. **The extremes of these models in terms of sea level rise are A1FI (high) and B1 (low).**

Modeling Adjustments

The models of the IPCC predicted a sea level rise of between 0.92-1.4 feet by 2099. These models *did not include* known factors for which there

was insufficient information to build predictive models. Our Scientific Advisor consequently gave us adjusted variables that allowed the Studio to calculate the likely timeframe for climate change impact. The adjustments to the IPCC modeling effected timeframe, only.

We studied the extreme SRES-scenarios, adjusted for factors that were left unaddressed by the IPCC (resulting in two study scenarios: A1FI+ and B1+).

MODELING CONCLUSIONS

Sea Level Rise

Our calculations indicated that a sea level rise of 1-foot between 2050-2075 is almost inevitable. Because the lag time for climate change is so great (between 200-1000 years, depending on the variable), **it is highly likely that the study area will undergo a 1-to-3 foot sea level rise,** regardless of how quickly and effectively greenhouse gas emissions are mitigated. This magnitude will have a very real impact on the study area.

Storm Severity

The increased atmospheric moisture associated with global warming is expected to lead to increased mean precipitation overall. A change in extreme precipitation larger than the mean is expected. Climatological data show that the most intense precipitation occurs in warm regions (like the study area) and diagnostic analyses have shown that, even without any change in total precipitation, higher temperatures lead to a greater proportion of total precipitation in heavy and very heavy precipitation events. As total precipitation increases a greater proportion falls in heavy and very heavy events.

Modeling of the coastal area is uncertain regarding total net precipitation; more intense storms, including hurricanes, are expected.

PENINSULA URBAN IMPACT

The two greatest direct impacts on urban design due to global climate change will be sea level rise and increased storm intensity. Significant when taken alone, these two factors have compounding implications in the study area: as sea level rises, so will the water table. This reduces the vertical fall available for drainage and below-grade capacity for storm water retention. As both effects are predicted to worsen over time, so the problem of collecting and managing runoff will become more difficult as the distance between land and the water table decreases. The problem of land settlement around the periphery of the peninsula will exacerbate this problem.

Consequently, most of the efforts of our study focused on ways to stop water intrusion from outside the peninsula while managing the increased severity of precipitation within.

The study area's stormwater drainage system is already inadequate to handle current severe storm events. It is also incapacitated by peak tides, which infiltrate the system and create inland ponding. As storm and hurricane severity increases and sea level rises under global climate change, storm water management will be a significant problem. Not only will property be threatened, but access to the principle health care center in the region will be compromised, as will evacuation routes.

The opposing demands of sea level rise and increasingly severe precipitation will put the peninsula in a double-bind: *a wall that keeps seawater out will keep rainwater in*. Below-grade stormwater piping will increasingly be subject to infiltration; gravity-run drainage systems will run out of "drop" between land-surface and sea. Increasing quantities of stormwater will have to be temporarily stored as the stormwater system loses its current (inadequate) capacity to drain.

STUDY STRUCTURE—BENCHMARKS

As a way of understanding urban design impact, we set up four orders of magnitude in sea level rise, M1-M4.

M3: The principal benchmark of the study we called M3, approximately equal to the street elevation of the historic downtown, 6-foot sea level rise. This is the point at which the downtown would be regularly inundated unless protective measures are taken and the historic value of the settlement negated.

M1: We set M1 equal to just 1-foot of rise, an unavoidable and certain impact.

M2: At 3-foot rise, M2 models the interim condition between M1 and M3. Our research indicates that M2 is a certainty.

M4: We set M4 to equal twice M3, or 12-foot sea level rise. (If M4 seems drastic, it should be remembered that if the ice on Greenland alone were to melt, sea level is predicted to rise by 25 feet. Greenland is currently melting.)

Water Level Predictions

Sea level in the harbor of the study area is currently 5.69' above sea level. According to the SRES models, sea level will rise an average of 0.92' (B1) to 1.4' (A1FI) by 2100. There is reason to believe that thermal expansion off the coast of the study area, and thus sea level, will be higher than global average. This study takes a

more aggressive (some would say "realistic") estimate of ice melt by doubling the IPCC's rate per decade (see Modeling Adjustments).

Accordingly, sea level would increase to the order-of-magnitude benchmarks as follows:

- M1:** +1' ELE 6.69' by 2050 in B1+ and A1FI+
M2: +3' ELE 8.69' by 2100 in B1+ and 2075 in A1FI+
M3: +6' ELE 11.69' by 2115 in A1FI+
M4: +12' ELE 17.69' by 2190 in A1FI+

Storm Predictions

The 90th percentile of a 50-year storm for the study area is approximately 6" precipitation in 24 hours. This study assumes that percolation and the existing stormwater infrastructure will handle 2"/day, leaving 4"/day currently unhandled.

While the IPCC notes the unreliability of weather modeling, it shows predictions for some SRES models and offers a 5% increase by 2100 as a high projection under a B1 world. There is no projection for the severity of storms, which are expected to get worse even if total precipitation drops.

In terms of urban design, the critical issue is managing water during severe storms. As it is unrealistic to plan for the worst potential event, **we have planned for the 90th percentile of a 50-year storm. We assume a steady increase of 0.1% per year in a B1+ world, and 0.2% per year in an A1FI+ world, for the targeted 90th percentile 50-year storm.**

M1 SUMMARY

Sea Level Rise

When sea level rises 1-foot, infiltration impact is limited largely to the western edge of the peninsula. **We believe that up to 1-foot of sea level rise can be handled by actively nurturing and expanding marsh lands** (which may also require limits on adjacent development).

M1-M2 SUMMARY

Precipitation Intensity

While global climate change models for the study area cannot yet predict an annual precipitation differential, it is thought that storms will become more severe, dropping more water in single events. **Storm severity may be the most troublesome impact for sea level increase up to M1.** Furthermore, the City's primary health emergency center is in jeopardy of being cut off from the region, due to low-lying roads. Consequently, **storm water retention and management along with maintaining critical transportation routes will likely be the primary urban design impact through the M1 scenario.**

Design Opportunity

Although global climate change will have serious practical impacts, the study proposes that these problems be addressed by *also* making positive urban changes: expanding civic space, improving recreational and aesthetic amenities, and looking beyond strictly historical precedent for urban possibility.

Design Strategies

Regarding storm water retention, the study identifies several opportunities:

>Retention Parks: **We envision a series of new water-based retention parks.** Because the ridge of the peninsula runs roughly along the longitudinal center, these parks need to be approximately half-way between the commercial core and the periphery where they can collect excess runoff.

>Elevated Crosstown: The best opportunity for a large mid-peninsula retention park is under the highway known locally as the "Crosstown," which is already low lying and regularly floods. Beyond its useful life, **the Crosstown should be raised and a new retention park built below that will increase recreation amenities, lift essential roadways to the regional medical district above stormwater, and reconnect neighborhoods north and south of the Crosstown.** Although elevated roadways often been urbanistically detrimental, the situation requires a reconsideration and reinvention of the typology.

>Paving Standards: The study recommends that the City and County investigate the efficacy of **converting its streets and parking lots into retention banks by a combination of pervious pavements and porous substructures.** Low lying highly pedestrian areas are also recommended for consideration.

>Retention Practices: The study recommends that **all new developments, large and small, be required to retain their own storm water.** Gray water systems and other water conservation practices are recommended.

M2 SUMMARY

Sea Level Rise

By M2 (3-foot sea level rise), extensive sections of the peninsula's banks that are not currently walled will have to be raised and strengthened, effecting most of the western bank and a long section of the eastern bank of the peninsula.

>Retention Fields: The new defensive perimeter offers the chance to **capture large volumes of retention capacity between the new walled (or swaled) edge and the existing land.**

>Green Necklace: A great civic design opportunity brought about by this new perimeter wall is to expand and complete the “Green Necklace,” a local urban design ideal that aspires to **ring the peninsula with public space**. By allowing high density development at limited sections along this new perimeter, private development could partially fund the expensive new measures.

Due to the lag time of environmental effects, the conditions envisioned for M2 are almost a certainty. Our modified IPCC modeling predicts M2 conditions between 2075-2100. If aggressive environmental measures are adopted, globally and in the near future, conditions may not get worse than the M2 scenario.

M3-M4 SUMMARY

With a greater than 3-foot rise in sea level, the historic relation between the City and the water will be radically changed. As sea level rises above +3-feet, a series of costly long-range commitments will have to be made. Consequently, the M3 scenario is really a threshold at which more drastic conditions that are better foretold in the M4 scenario begin.

M4 SUMMARY

We examined two long-range approaches at a +12-foot order of magnitude: harbor armament and a canal city.

SCHEME 1: Harbor Armament (Levee)

If the coastal region is to be saved, or if the peninsula is to retain any kind of historic water relationship, an extensive levee will be required. Because the study area is bounded by rivers that will rise with sea level, upstream sources will also have to be diverted or managed, fundamentally changing water management throughout the State.

Without considering extra-peninsular lands, we charted a levee on the shortest line that would circumnavigate the harbor and connect to the requisite inland elevations.

If a levee is constructed, then the peninsula’s water relationships can maintain their historic conditions—provided the increased storm water can be managed.

SCHEME 2: CANAL CITY

If a levee is not constructed, then the City will become a walled peninsula requiring a perimeter barrier rising several feet above current street level. Although a bounding wall would cut the City off from the water, both physically and in terms of view, we explored the conversion of streets on the southern end of the peninsula into

canals. Like Venice, the city would embrace its connection to the sea. Because dry land will exist by virtue of pumping, the canals will also be important for managing storm runoff and retention.

Starting in M3, we envisioned raising the grade elevation of the lower southwest quadrant of the downtown, as a new sea wall is constructed in that area. Over the coming centuries, all buildings in this area (most of which are not historic and built on fill) will be rebuilt any way; new grade elevations can be established and foundations lifted. For the canal system to work, the downtown area will need a consistent elevation.

Although we refrained from considering cultural and social implications, it is inescapable that a walled peninsula could only be justified to save the historic assets of this city; consequently, it seems inevitable that the culture and economy of the city would become essentially touristic.

CONCLUSION

This study imagines the urban implications of sea level rise and increased storm precipitation brought on by global climate change. The first reaction of most viewers at the exhibition was to look for their homes and businesses on our Order of Magnitude maps. Clearly, this brought the issue home.

The study alerts us to the primary issues of concern (the mutually exacerbating problems of sea level rise and increased storm precipitation), but it also proposes opportunities for improving the public realm in addressing these issues.

The study fails to consider issues beyond the peninsula nor does it envision a transformed, ecologically friendly, transportation and energy infrastructure.

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