Supplementary Information

Simulation-Based Learning Environments to Teach Complexity: The Missing Link in Teaching Sustainable Public Management

Below is an abbreviated table of contents indicating the broad contents of these appendices:

Appendix A: Restatement and Elaboration of 5 NASPAA Core Competencies by MPA Faculty of the Rockefeller College. This appendix contains a statement of the 5 NASPAA Core Competencies plus additional elaborations on these competencies as adopted by the faculty of Public Administration and Policy at the Rockefeller College, University at Albany.

Appendix B-1 Global Warming and the Pointe Claire Regional Coastal Planning Commission—Part 1.A. This appendix sets up the basic conditions of the assignment for the rest of the class. The first part of the assignment is directed toward a class exercise where the students interact with the C-Roads Climate Change Simulator.

Appendix B-2 Global Warming and the Pointe Claire Regional Coastal Planning Commission—Part 1.B (class exercise with C-Learn Model). Thus appendix contains the handout that was used in class for the C-Roads Simulator exercise.

Appendix B-3: Roles for Global Warming and the Pointe Claire Disaster Preparedness Case. The Pointe Claire Case had a number of class-based role playing exercises. This document describes the basic roles that students assumed during the class exercises.

Appendix B-4: Notes for Formulating a Simple Difference Equations Model for Pointe Claire Coastal Protection. The class had a homework assignment requiring them to formulate some of the key dynamic structures within the CoastalProtectSIM model. This is a worksheet that groups of students using during a class lab to get started on the homework assignment.

Appendix B-5: Global Warming and the Pointe Claire Regional Coastal Planning Commission—Part 2. The final assignment had two main parts. Working in small groups, each team crafted a short presentation that used the simulator to create a "solution" for the Pointe Claire Regional Planning Commission. In addition, as an individual assignment, each student drafted a policy memo addressed to the Director of the Commission giving her advice on how to use a formal simulation model to support policy formation. This document sets up both of those assignments as well as directs students to background readings on stakeholder analysis and management, material that had been previously assigned in another MPA core class.

Appendix A: Restatement and Elaboration of 5 NASPAA Core Competencies by MPA Faculty of the Rockefeller College

Department of Public Administration and Policy,
Rockefeller College NASPAA Competencies Defined August 2012 DRAFT

#1: The Ability to Lead and Manage in Public Governance

An MPA graduate from Rockefeller College will be able to energize people and resources in the pursuit of publically defined policy goals in a manner that respects multiple perspectives and recognizes consequences of their actions.

- Within organizations, our MPA graduates will:
  - *Demonstrate* leadership in personal work and group settings;
  - *Prioritize* activities in a manner consistent with organizational strategy and performance goals, regardless of their position in the hierarchy; and
  - *Facilitate*, plan, and manage projects to meet organizational goals.
- To those outside of their organizations, out MPA graduates will:
  - *Display* responsible stewardship of public resources and accountability to the public interest;
  - *Coordinate* actions with multiple organizations;
  - *Navigate* the competing interests of other governmental and non-governmental actors.

#2: To Participate in and Contribute to the Policy Process

An MPA graduate from Rockefeller College will substantively participate in the design, implementation, and evaluation of public policy. An MPA graduate will be able to:

- *Formulate* policy objectives and priorities that are consistent with their organization's mission.
- *Facilitate* change by developing new insights, questioning conventional approaches, and encouraging novel ideas and innovations within legal, political, and institutional constraints.
- *Participate* in the development of networks spanning organizational boundaries to build strategic relationships to achieve common goals.
- *Evaluate* whether public, private, or non-profit sectors may be more effective in achieving policy goals.
- *Balance*:
  - Conflicting and interdependent interests of multiple constituencies;
  - Program performance, legal requirements, political constraints, and equity concerns when evaluating policy.

#3: To Analyze, Synthesize, Think Critically, Solve Problems and Make Decisions

An MPA graduate from Rockefeller College will substantively contribute to evidence-based decisionmaking that appropriately analyzes information and recognizes stakeholders' competing values. This is achieved by:

- *Analyzing* information to define and evaluate program performance by:
    - Breaking complex problems into constituent parts;
    - Assessing relevance, bias, and accuracy of information;
    - Comparing information from multiple sources; and
    - Organizing information using appropriate quantitative and/or qualitative methodologies to identify meaningful patterns.
- *Identifying* potential solutions to problems by:
    - Differentiating between short- and long-term problems and solutions;
    - Evaluating policy options in light of competing political interests, organizational priorities, equity; and efficiency; and
    - Making decisions in the face of limited information, ambiguity, and time constraints.
- *Communicating* recommendations in a manner that:
    - Articulates actionable recommendations;
    - Assesses the significance of problems and solutions;
    - Prioritizes proposals;
    - Explains positive and negative implications of options; and
    - Provides well-documented analysis that will stand up to public scrutiny.

#4: To articulate and apply a public service perspective

An MPA graduate from Rockefeller College is motivated by a sense of responsibility to improve social welfare. An MPA graduate will:

- *Articulate* what it means to promote principles of equity, representativeness, responsiveness, transparency, and fair process in protecting citizens' rights;
- *Demonstrate* these values in their interactions with diverse constituencies;
- *Describe* tradeoffs of implementing public policies through the public, private, and/or non-profit sectors; and
- *Act* in a manner that:
    - demonstrates a sense of duty, ethics, and integrity,
    - minimizes conflicts of interest, and
    - builds public trust.

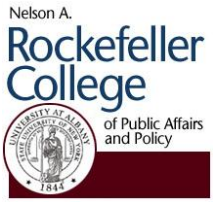
#5: To communicate and interact productively with a diverse and changing workforce and citizenry

An MPA graduate from Rockefeller College will professionally represent their organization's interests to stakeholders by:

- *Presenting* information, in writing and orally, that is concise, accurate, clear, and informed by evidence;
- *Tailoring* information to diverse audiences;
- *Facilitating* involvement and cooperation, building consensus, and motivating stakeholders to accomplish shared policy goals;
- *Seeking out*, considering, and incorporating diverse perspectives; and
- *Demonstrating* courtesy, sensitivity, and respect when interacting with diverse audiences.

Appendix B: Curriculum Materials Developed and Used in the Fall 2012 PAD 504 Class

Appendix B-1 Global Warming and the Pointe Claire Regional Coastal Planning Commission—Part 1.A



Rockefeller College
University at Albany

Global Warming and the Pointe Claire Regional Coastal Planning Commission—Part I.A

The period in the immediate aftermath of Hurricane Katrina's devastating strike on the city of New Orleans was a period of both thankfulness and sober reflection for the residents of the Pointe Claire Regional Coastal Planning District (PCRCPD). In the days and hours leading up to Katrina's landfall, Pointe Claire had, for a short while, been designated as the ground zero point to receive the brunt of Katrina's force. Hence residents of Pointe Claire were thankful when the storm veered off for its landfall at New Orleans. But even being over one hundred miles from New Orleans was not enough to spare the Pointe Claire coastal communities from significant damage. Now was a time for sober reflection on what to do to prevent the next (inevitable) storm from taking an even greater toll.

Luz Sansouci, Director of the Pointe Claire Regional Coastal Planning District was the first to answer a call from the US Army Corps of Engineers to participate in a *Shared Vision Planning* (Shared Vision Planning is a collaborative, community and model-based process that the U.S. Army Corps of Engineers is developing to develop community-based input, alignment with, and subsequent commitment to Corps projects within a specified geographic region. For more information on this innovative model-based planning process, see http://sharedvisionplanning.us/) exercise designed to align all major stakeholders in the region around a plan to rebuild the regional dike and sea barrier system as well as promote the natural ability of the landscape around Pointe Claire to absorb the impact of future storms. She was delighted that her community would be engaged in this long range planning process in less than a year, and she vigorously began to assemble her stakeholder planning group and to engage in preliminary discussions, hopefully moving toward alignment within her community.

More about the Pointe Claire Region. The communities of the Pointe Claire Regional Coastal Planning District are clustered around the geography of Pointe Claire itself, a peninsula that juts south into the Gulf of Mexico. Residential, commercial, and touristic development on Pointe Claire is spread along its eastern shore. A series of protective sandbars and beaches provide an almost perfect environment for residential and touristic development. A series of small towns dot the eastern shore providing shopping and other commercial opportunities. In the late 1980s, the U.S. Army Corps of Engineers conducted a survey of the eastern shore and subsequently constructed a comprehensive set of dikes and sea barriers designed to protect all communities and evacuation routes up to the mean maximum surge levels. An extra margin of error allows for additional protection that relies on sand-bagging and other

citizen efforts when a "once in a century" extreme event (such as hurricane Katrina) is forecast. These systems have worked well in the past and all held through hurricane Katrina.

Indeed, the Corps's comprehensive protections system has proven a boon to local developers. Developers who respect the Corps' safety-designated areas can and do apply for government-backed flood insurance. Buoyed by a sense of security, residential, commercial, and tourist-related development has been possible.

The western shore of Pointe Claire is a somewhat different story. Salt marsh wetlands penetrate deeply inland making north-south highways along the coast more difficult to construct and with limited access has come less development. However, less development has made it more attractive, due to its rural nature, and development has occurred, but on larger lots that are more environmentally friendly. Because of the basic geography of the western shore and its less intense pattern of development, the US Army Corps of Engineers did not deem it necessary to build such a high level of protective barriers. Indeed, undeveloped salt marsh areas provide a natural buffer against storms and hurricanes that may hit Pointe Claire from the west.

Composition of the Commission's Advisory Panel. Luz Sansouci has been particularly concerned about achieving a good balance among the various stakeholders who all care deeply about coastal development in the Pointe Claire region. She has sought input from residents and community leaders on both the eastern and western shores. Representatives of east shore communities have been eager to participate in the *Shared Vision Planning* effort because they view involvement of the Army Corps of Engineers as a way to guarantee a storm-safe community, paving the way for future residential and commercial development linked to job creation. Youris Sabo, Executive Director of the Pointe Claire Regional Business Association, is a vocal spokesperson for this point of view on the Pointe Claire Regional Coastal Planning advisory committee. His basic position is that the Corps should build and protect to promote development and jobs.

Hanne Daniele, a resident of the western shore, represents a different point of view. She was initially drawn to Pointe Claire's western shore by its undeveloped beaches, marsh wetlands, and environmentally rich coastal areas. As the current President of the Pointe Claire Environmental coalition, she is interested in promoting strategies that support the natural ability of the coastline to absorb damage. As such, she is less excited about protective construction and more interested in land use and development policies that sharply restrict coastal development to create a natural ability to absorb the brunt of a storm. She even favors a program of land reclamation in those areas where development has already begun to encroach upon environmentally sensitive areas. Already Luz sees conflict shaping up on her board with developers favoring protective construction and environmentalists advocating for regulated development and in some cases reclamation of environmentally sensitive areas.

Global Warming as a Possible Factor in Pointe Claire's Local Decision Making. The potential conflict materialized at the very first meeting of the advisory group when Hanne Daniele introduced what would turn out to be an ultimately divisive issue into the group's discussions. She brought up the issue of global warming and its possible future impact on long-term development and Corps projects in Pointe Claire. Hanne Daniele argued that over the next 40 years, the announced planning horizon of the Corp's Shared Vision Planning projects, global warming would have a major impact on the Pointe Claire ecosystem and its ability to withstand future storms such as hurricane Katrina. She cited three factors. First, anticipated sea level rise from global climate change would reduce the margin of safety

in existing and future projected protective systems. Second, global warming could have the effect of increasing the mean high storm surge implying that for "normal" storms an even greater level of protection from both constructed systems and natural barriers would be required. Finally, global warming could increase the volatility of storm systems making outlier "once in a century" storms both more probable and possibly more severe. Hanne Daniele argues strenuously that these key factors must be taken into account in any future plans for Point Claire.

Youris Sabo was quick to counter that global warming, while certainly one of many possible futures, was currently based on no observed facts, scientific projections based on computer models of unknown validity, and a whole lot of speculation and confusion. In his opinion, it would not be wise to take steps that could suppress development and much needed job creation in the here and now to appease future-possible allegedly powerful environmental scenarios in a projected or simulated future. Youris Sabo cited a letter to the editor of the *Wall Street Journal* by 16 prominent scientists that made these points better than he ever could(See the letter and subsequent debate in Appendix A). Furthermore, any Google search of the internet would easily uncover global warming experts who are also global warming skeptics and more cautious scientists who are also not willing to so quickly trade present and tangible benefits in the form of development and jobs in the here and now for future-possible, not-so-clear adverse possibilities.

The C-ROADS Global Warming Simulator. Hanne Daniele had suggested that the PCRCPC look to a newly available modeling capability, the C-ROADS Global Warming Simulator, as a possible tool to support local decision making in the Pointe Claire region(The C-ROADS simulator along with associated explanatory material can be found at: http://climateinteractive.org/simulations/C-ROADS). The C-ROADS Simulator was initially developed by modelers from MIT's systems engineering group working in conjunction with a team of climate change experts and system scientists. Initially developed during the global climate change meetings in Copenhagen in 2009 to support international negotiations to limit CO2 emissions, the simulator had subsequently been modified to support learning exercises for citizens, students, and policy makers from all backgrounds. The simulator is not a full-scale climate change simulation, but rather a high fidelity policy model capable of closely reproducing major policy implications of a range of extant large-scale, science-based climate change simulators.

Your Assignment. You are a newly minted MPA from the Rockefeller College who has been hired by Luz Sansouci to broadly support all of the executive functions of the PCRCPC. Your duties include providing staff support to the advisory group that Luz is assembling to work with the Army Corps or Engineers. Luz has asked you to look into the various aspects of the global warming issue and what might the impacts be, if any, of these issues on the upcoming work with the Army Corp's *Shared Vision Planning* project. Specifically, Luz has asked you to become familiar with the C-ROADS simulator and evaluate it as a possible tool to be used by the advisory group. She is a bit skeptical about using a global simulation to support what is essentially a local planning process. Further, she recognizes that even introducing global warming as an issue in the local planning process could be highly divisive. Environmental activists are likely to view global warming as an issue to invoke overly cautious planning assumptions. On the other hand, those interested in continuing economic development in the region are likely to see this issue as a red herring that will ultimately curtail the ability of the region to further develop, generate jobs, and be economically successful.

Luz has asked you to generate a short and focused policy memo that summarizes the Strengths, Weaknesses, Opportunities, and Threats (a classic "SWOT" analysis) that might be associated with even starting to engage with the C-ROADS global simulator to support discussions within the Advisory Group.

Attachments

1. Letter of Climate Change Skeptical Scientists to the *Wall Street Journal*, 27 January 2012 (with references to on-going rebuttal and debates).
2. Further notes on content and focus of Pointe Claire case, models, and problem sets.

Attachment 1: Letter of Climate Change Skeptical Scientists to the *Wall Street Journal,* January 27, 2012 (with references to on-going rebuttal and debates)

No Need to Panic about Global Warming
16 scientists (names at end of article)
Wall Street Journal
27 January 2012
http://online.wsj.com/article/SB10001424052970204301404577171531838421366.html

Editor's Note: The following has been signed by the 16 scientists listed at the end of the article:

A candidate for public office in any contemporary democracy may have to consider what, if anything, to do about "global warming". Candidates should understand that the oft-repeated claim that nearly all scientists demand that something dramatic be done to stop global warming is not true. In fact, a large and growing number of distinguished scientists and engineers do not agree that drastic actions on global warming are needed.

In September, Nobel Prize-winning physicist Ivar Giaever, a supporter of President Obama in the last election, publicly resigned from the American Physical Society (APS) with a letter that begins: "I did not renew (my membership) because I cannot live with the (APS policy) statement: 'The evidence is incontrovertible: Global warming is occurring. If no mitigating actions are taken, significant disruptions in the Earth's physical and ecological systems, social systems, security and human health are likely to occur. We must reduce emissions of greenhouse gases beginning now'. In the APS it is OK to discuss whether the mass of the proton changes over time and how a multi-universe behaves, but the evidence of global warming is incontrovertible?"

In spite of a multidecade international campaign to enforce the message that increasing amounts of the "pollutant" carbon dioxide will destroy civilization, large numbers of scientists, many very prominent, share the opinions of Dr. Giaever. And the number of scientific "heretics" is growing with each passing year. The reason is a collection of stubborn scientific facts.

Perhaps the most inconvenient fact is the lack of global warming for well over 10 years now. This is known to the warming establishment, as one can see from the 2009 "Climategate" email of climate scientist Kevin Trenberth: "The fact is that we can't account for the lack of warming at the moment

and it is a travesty that we can't". But the warming is only missing if one believes computer models where so-called feedbacks involving water vapor and clouds greatly amplify the small effect of CO_2.

The lack of warming for more than a decade—indeed, the smaller-than-predicted warming over the 22 years since the U.N.'s Intergovernmental Panel on Climate Change (IPCC) began issuing projections—suggests that computer models have greatly exaggerated how much warming additional CO_2 can cause. Faced with this embarrassment, those promoting alarm have shifted their drumbeat from warming to weather extremes, to enable anything unusual that happens in our chaotic climate to be ascribed to CO_2.

The fact is that CO is not a pollutant. CO_2 is a colorless and odorless gas, exhaled at high concentrations by each of us, and a key component of the biosphere's life cycle. Plants do so much better with more CO_2 that greenhouse operators often increase the CO_2 concentrations by factors of three or four to get better growth. This is no surprise since plants and animals evolved when CO_2 concentrations were about 10 times larger than they are today. Better plant varieties, chemical fertilizers and agricultural management contributed to the great increase in agricultural yields of the past century, but part of the increase almost certainly came from additional CO_2 in the atmosphere.

Although the number of publicly dissenting scientists is growing; many young scientists furtively say that while they also have serious doubts about the global-warming message; they are afraid to speak up for fear of not being promoted—or worse. They have good reason to worry. In 2003; Dr. Chris de Freitas; the editor of the journal Climate Research; dared to publish a peer-reviewed article with the politically incorrect (but factually correct) conclusion that the recent warming is not unusual in the context of climate changes over the past thousand years. The international warming establishment quickly mounted a determined campaign to have Dr. de Freitas removed from his editorial job and fired from his university position. Fortunately, Dr. de Freitas was able to keep his university job.

This is not the way science is supposed to work, but we have seen it before—for example, in the frightening period when Trofim Lysenko hijacked biology in the Soviet Union. Soviet biologists who revealed that they believed in genes, which Lysenko maintained were a bourgeois fiction, were fired from their jobs. Many were sent to the gulag and some were condemned to death.

Why is there so much passion about global warming, and why has the issue become so vexing that the American Physical Society, from which Dr. Giaever resigned a few months ago, refused the seemingly reasonable request by many of its members to remove the word "incontrovertible" from its description of a scientific issue? There are several reasons, but a good place to start is the old question "cui bono?" Or the modern update, "Follow the money".

Alarmism over climate is of great benefit to many, providing government funding for academic research and a reason for government bureaucracies to grow. Alarmism also offers an excuse for governments to raise taxes, taxpayer-funded subsidies for businesses that understand how to work the political system, and a lure for big donations to charitable foundations promising to save the planet. Lysenko and his team lived very well, and they fiercely defended their dogma and the privileges it brought them.

Speaking for many scientists and engineers who have looked carefully and independently at the science of climate, we have a message to any candidate for public office: There is no compelling scientific argument for drastic action to "decarbonize" the world's economy. Even if one accepts the inflated climate forecasts of the IPCC, aggressive greenhouse-gas control policies are not justified economically.

Princeton physics professor William Happer on why a large number of scientists don't believe that carbon dioxide is causing global warming.

A recent study of a wide variety of policy options by Yale economist William Nordhaus showed that nearly the highest benefit-to-cost ratio is achieved for a policy that allows 50 more years of economic growth unimpeded by greenhouse gas controls. This would be especially beneficial to the less-developed parts of the world that would like to share some of the same advantages of material well-being, health and life expectancy that the fully developed parts of the world enjoy now. Many other policy responses would have a negative return on investment. And it is likely that more CO_2 and the modest warming that may come with it will be an overall benefit to the planet.

If elected officials feel compelled to "do something" about climate, we recommend supporting the excellent scientists who are increasing our understanding of climate with well-designed instruments on satellites, in the oceans and on land, and in the analysis of observational data. The better we understand climate, the better we can cope with its ever-changing nature, which has complicated human life throughout history. However, much of the huge private and government investment in climate is badly in need of critical review.

Every candidate should support rational measures to protect and improve our environment, but it makes no sense at all to back expensive programs that divert resources from real needs and are based on alarming but untenable claims of "incontrovertible" evidence.

Claude Allegre, former director of the Institute for the Study of the Earth, University of Paris; J. Scott Armstrong, cofounder of the Journal of Forecasting and the International Journal of Forecasting; Jan Breslow, head of the Laboratory of Biochemical Genetics and Metabolism, Rockefeller University; Roger Cohen, fellow, American Physical Society; Edward David, member, National Academy of Engineering and National Academy of Sciences; William Happer, professor of physics, Princeton; Michael Kelly, professor of technology, University of Cambridge, U.K.; William Kininmonth, former head of climate research at the Australian Bureau of Meteorology; Richard Lindzen, professor of atmospheric sciences, MIT; James McGrath, professor of chemistry, Virginia Technical University; Rodney Nichols, former president and CEO of the New York Academy of Sciences; Burt Rutan, aerospace engineer, designer of Voyager and SpaceShipOne; Harrison H. Schmitt, Apollo 17 astronaut and former U.S. senator; Nir Shaviv, professor of astrophysics, Hebrew University, Jerusalem; Henk Tennekes, former director, Royal Dutch Meteorological Service; Antonio Zichichi, president of the World Federation of Scientists, Geneva.

This is the citation for the above letter to the editor:

"No need to panic about global warming," 27 January 2012, *Wall Street Journal.*
http://online.wsj.com/article/SB10001424052970204301404577171531838421366.html

Further citations that rebut and debate this article have been loaded on the class Blackboard site. The articles located on the Blackboard site do not have some of the additional material that can be found at the full online sites. The fuller online material can be found at:

22 March 2012. William D. Nordhaus "Why the Global Warming Skeptics are Wrong," *New York Review of Books.*
http://www.nybooks.com/articles/archives/2012/mar/22/why-global-warming-skeptics-are-wrong/?pagination=false

26 April 2012 "In the climate casino: An exchange". *New York Review of Books*. Roger W. Cohen, William Happer, and Richard Lindzen, reply by William D. Nordhaus.
http://www.nybooks.com/articles/archives/2012/apr/26/climate-casino-exchange/

August 16, 2012 "The climate contrarians". *New York Review of Books*. S. Fred Singer with a reply by William D. Nordhaus.
http://www.nybooks.com/articles/archives/2012/aug/16/climate-contrarians/

Attachment 2: Further Notes on Content and Focus on Pointe Claire Case, Models, and Problem Sets

The Pointe Claire case study presented here is the first in a series of integrated cases, models, and problem sets that are designed to be used for pedagogical purposes in a first semester modeling class in an MPA or MPP program. While the details of the Pointe Claire peninsula on the Gulf Coast of the United States are fictional, the basic situation facing coastal managers in areas of coastal storms is realistic. Climate change, while still hotly debated in the public press, is an important international force beyond the control of local governments that must be dealt with. It provides an imperative background of key scenarios that need to be considered in local planning decisions. The Army Corps of Engineers is certainly now engaged in planning efforts to create safe communities on the US Gulf coast (as are similar agencies in Asia, the Netherlands, and low-lying coastal regions around the world). The *Shared Vision Planning* system depicted in the case is an innovative planning tool currently under development with pilot projects already completed by the US Army Corps of Engineers. The C-ROADS Simulator was used at the Copenhagen CO_2 emission-control international summit and is currently being used as an educational tool by citizens and policy makers around the world.

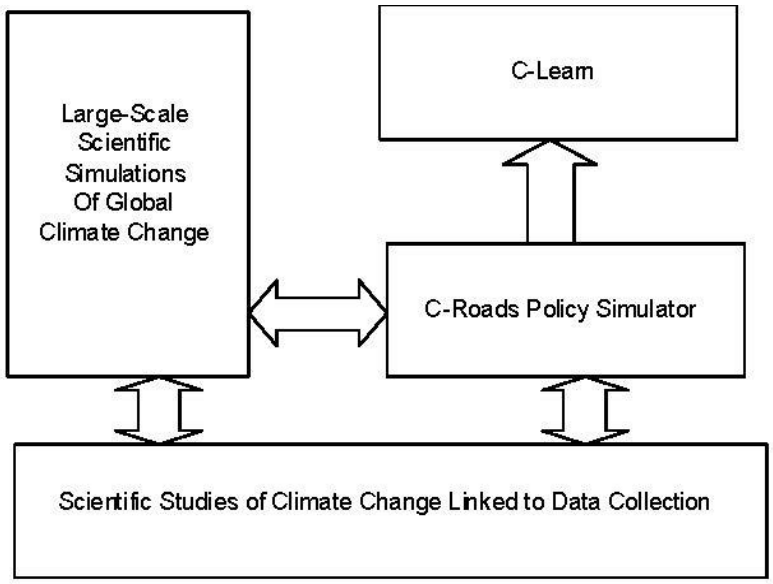
The case and models presented in the problem sets, while realistic representations of important public policy modeling efforts, have been simplified to make their details more apparent to a first semester student who is first learning about these modeling tools. The full series of models presents a basic decision tree, a series of difference equation models implemented in EXCEL as well as an EXCEL-based Multi-Attribute Decision model. These small models are depicted as part of problem sets designed for a first course in Data, Models, and Decisions. The final case assignment for this series presents a system dynamics model implemented in VensimPLE intended to be readily understood and used by a student in a first semester modeling course. It is of the complexity of a model that might emerge from a group model building (Group model building is a name for a series of facilitated techniques used to build a simulation model with a group of stakeholder working with modelers and facilitators over the course of one or more days of facilitated interactions. For more information on group model building please see "Andersen, D.F.; Vennix, J.A.M.; Richardson, G.P.; Rouwette, E.A.J.A. Group model building: Problem structuring, policy simulation and decision support. *J. Oper. Res. Soc*. **2007**, *58*, 691–695") session that might have been attended by members of the Pointe Claire Coastal Regional Planning Commission.

Appendix B-2 Global Warming and the Pointe Claire Regional Coastal Planning Commission—Part 1.B (class exercise with C-Learn Model)

Rockefeller College
University at Albany

Global Warming and the Pointe Claire Regional Coastal Planning Commission—Part I.B (class exercise with C-Learn Model)

Your assignment for Part I.A of the Global Warming and Pointe Claire case asks you to become familiar with the C-ROADS policy simulator and to make recommendations about its appropriate use by the Pointe Claire Regional Coastal Planning Commission. This assignment will take you directly into the middle of debates about climate change. In order to assess the utility of the C-ROADS policy simulator, we will use about an hour and a half of class time to interact with the C-Learn simulator. C-Learn is a simpler version of the C-ROADS system designed to educate policy makers, not actually support policy decisions. The figure below presents a simplified representation between C-Learn and other scientific and simulation studies.



Simplified Representation of Relationships Between C-Learn and Other Scientific and Simulation Studies

Basic data gathering and scientific studies provide the bedrock upon which all else must rest. Scientific simulators are large-scale computer models that purport to capture important scientific facts and relationships in long-range forecasts of climate change. The assumptions of these models are important to their ultimate conclusions and scientists hotly debate how to formulate many of the relationships in these models. Indeed, several competing large-scale simulations exist. The C-ROADS simulator purports

to be build on the same science as the large-scale simulators, but lacks much of the detail. The purpose of C-ROADS is to give policy makers a fast and easy-to-use simulation environment that allegedly captures all of the policy relevant details of the larger models, but can be easily used by a policy team (say a negotiating team at the Copenhagen Climate Change meetings). The C-Learn simulator is a version of the larger C-ROADS policy simulator that has been configured for easy on-line use by students and others interested in learning about climate change and how simulators can support policy formation.

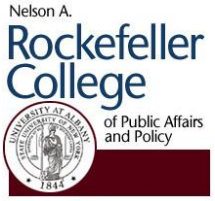
During our allocated class time, you will role play one of three groups of countries—Developed Economies, Developing Economies, and Less-Developed Economies. Taken together, these three groups encompass all of the world's economies. Your group's briefing sheet gives you information that you will need to play your group's position. More details on some of the scientific and political debates that are surrounding global climate change are contained in appendices to the original Pointe Claire Case study. To get more information on the C-ROADS simulator itself, you may wish to visit the URL: http://climateinteractive.org/simulations/C-ROADS.

Your assignment is to come to class prepared to play out several rounds of climate change negotiations using the materials included in your packet. Good luck!!!

Attachment

- Packet of Materials specific to your team's role in the C-Learn Exercise

Appendix B-3: Roles for Global Warming and the Pointe Claire Disaster Preparedness Case



Rockefeller College
University at Albany

Roles for Global Warming and the Pointe Claire Disaster Preparedness Case

Luz Sansouci, Director of the Pointe Claire Regional Coastal Planning District, was the first to answer a call from the US Army Corps of Engineers to participate in a *Shared Vision Planning* (Shared Vision Planning is a collaborative, community and model-based process that the U.S. Army Corps of Engineers is developing to develop community-based input, alignment with, and subsequent commitment to Corps projects within a specified geographic region. For more information on this innovative model-based planning process, see http://sharedvisionplanning.us/) exercise designed to align all major stakeholders in the region around a plan to rebuild the regional dike and sea barrier system as well as promote the natural ability of the landscape around Pointe Claire to absorb the impact of future storms. She was delighted that her community would be engaged in this long range planning process in less than a year, and she vigorously began to assemble her stakeholder planning group and to engage in preliminary discussions, hopefully moving toward alignment within her community. Luz is interested in process variables such as degree of consensus and alignment between members of the commission. However, Luz already sees conflict shaping up on her board with developers favoring protective construction and environmentalists advocating for regulated development and in some cases reclamation of environmentally sensitive areas.

Youris Sabo, Executive Director of the Pointe Claire Regional Business Association, is a vocal spokesperson for a pro development point of view on the Pointe Claire Regional Coastal Planning advisory committee. His basic position is that the Corps should build and protect to promote development and jobs. As a representative of east shore communities he has been eager to participate in the *Shared Vision Planning* effort because he views involvement of the Army Corps of Engineers as a way to guarantee a storm-safe community, paving the way for future residential and commercial development linked to job creation. He is interested in seeing more land made available for safe development, having storm damages avoided by construction projects. He believes that a local tax levy on newly developed parcels will be able, in part, to offset the local share of costs of any projects.

Hanne Daniele, a resident of the western shore, represents a different point of view. She was initially drawn to Pointe Claire's western shore by its undeveloped beaches, marsh wetlands, and environmentally rich coastal areas. As the current President of the Pointe Claire Environmental coalition, she is interested in promoting strategies that support the natural ability of the coastline to absorb damage. As such, she is less excited about protective construction and more interested in land use and development policies that sharply restrict coastal development to create a natural ability to

absorb the brunt of a storm. She even favors a program of land reclamation in those areas where development has already begun to encroach upon environmentally sensitive areas. Hanne is interested in seeing global warming taken into account in any future planning and she is especially concerned about environmental quality in the Pointe Claire Region. She would be concerned if too much new land were to come under development, preferring to see preservation and reclamation of environmentally sensitive areas. She is concerned about the present decline in undeveloped area.

Bud Listerton is the current President of the Pointe Claire Homeowners Association. His association is interested in seeing damage from storms avoided and having overall damages as low as possible. He is interested in having storm insurance available to home owners at a reasonable price and is interested in keeping down local taxes on homes as well as imposed fees on homeowners (for example for mandated compliance with building codes).

Erin Straiten is Regional Director of the US Army Corps of Engineers with overall responsibility for the Pointe Claire project. She is concerned with balancing costs and benefits of the project, emphasizing efficient building and other policies that avoid damages while at the same time limiting costs. Overall, she is interested in low cost solutions to the whole system of problems. She is interested in projected damage costs, building and remediation costs, reclamation costs, as well as estimates of avoided damage costs. She has the best appreciation for the need for planning for low probability high impact events such as once in a century storms.

Appendix B-4: Notes for Formulating a Simple Difference Equations Model for Pointe Claire Coastal Protection

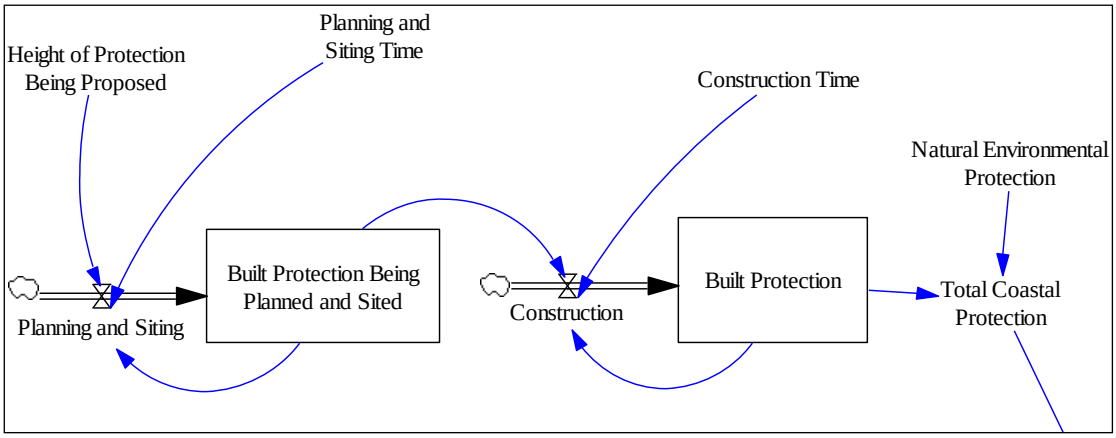
Notes for Formulating a Simple Difference Equations Model for Pointe Claire Coastal Protection PAD 504: Data, Models, and Decisions I

Important aspects of the Pointe Claire Coastal Protection effort can be modeled with a set of difference equations. If the difference equations can have random effects in them, then the over time dynamics can also incorporate important aspects of stochastic uncertainty—the type of problem that you have already analyzed in the Pointe Claire decision tree exercise.

This worksheet is divided into four smaller pieces that give you tips and pointers for how to formulate (that is, write equations for) specific sectors of the Pointe Claire difference equation simulator. When these several pieces are pasted together, we will have an interesting (but still quite simple) model of the Pointe Claire Coastal Protection system.

Good luck both with your piece and with the overall simulation!!!

Figure 1. Coastal Protection Sector.



This figure shows that the total coastal protection is the simple sum of Natural Environmental Protection and Built Protection. For the purposes of this simple model the height of Natural Environmental Protection is 150 inches. This means that if a storm surge is 150 inches or less, the natural environment in Pointe Claire, on aggregate, would be able to handle. The simulation adds built protection on top of Natural Environmental Protection. The user can select how much protection to build with the "Height of Protection Being Proposed" variable. It is initially set to 0. Planning and Siting Time is set to 4 years and Construction Time is set to 10 years. This means that the simulation will plan, site, and construct any requested protection over a time range centered around 14 years.

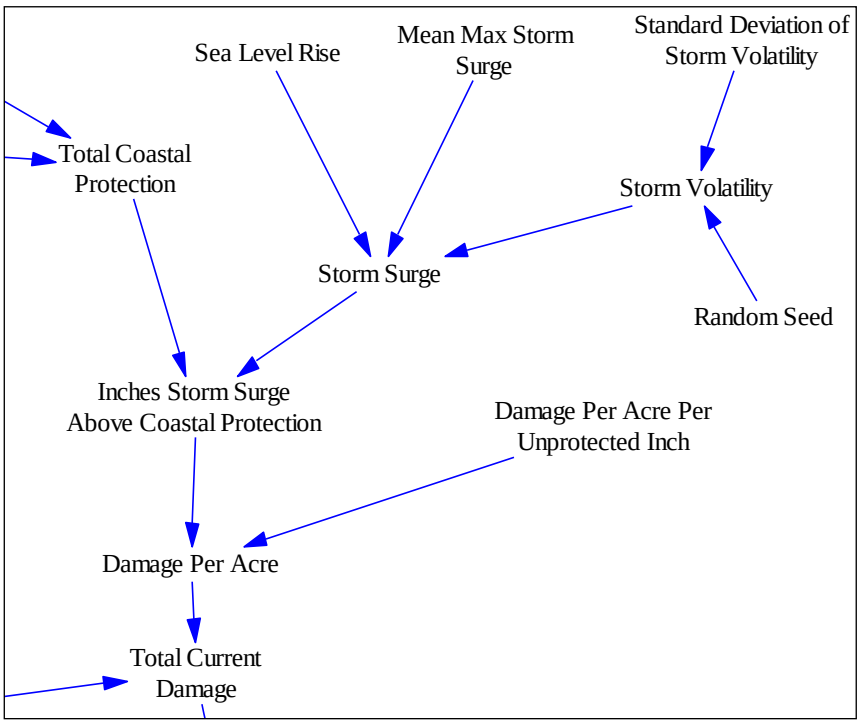
The Height of Protection Being Proposed variable serves as a goal for Planning and Siting Activities. The "Flow of Planning and Siting" is computed by a "Goal Gap" formulation of the following form:

Planning and Siting = (Height Proposed − Protection Being Planned)/Planning & Siting Time

You will need to formulate a similar equation for Construction, except that the goal for actual construction is the stock of Build Protection Being Planned and Sited that actually exists at any point in time.

Once you have formulated all of these equations, you should be able to run this small sector of the model on its own to see how it runs and to check that all of the equations are OK. Ask your instructor if you are having problems with any of these formulations.

Figure 2. Calculation of Storm Surge and Damage in Each Time Period.

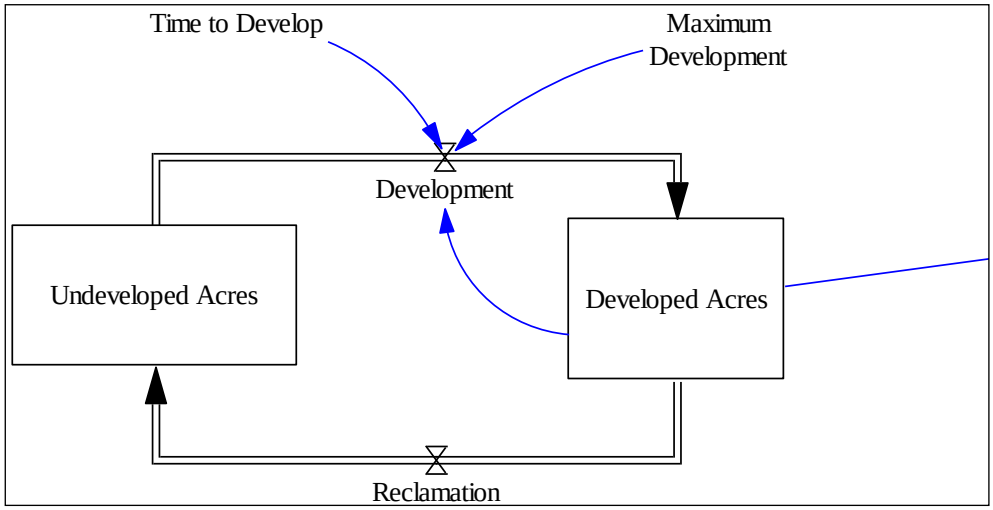


The best place to start to formulate this section of the model might be to look at the calculation of the number of Inches Storm Surge above Coastal Protection variable. This is calculated by subtracting Total Coastal Protection (which you calculated above as 150 inches plus any Built Protection) minus Storm surge. Make sure to use a "MIN" or "MAX" function so that you don't get negative inches of storm surge above protection (that would generate negative Damages per Acre). As a slam dunk simple formulation, the model assumes that Damage per Acre is the number of unprotected inches times $1,000, the variable Damage per Acre per Unprotected Inch. Of course, a more realistic model would have a more elaborated damage function. Total Current Damage is simply the Damage per Acre times the number of Developed Acres. Initially, the model shows 7,500 Developed Acres.

The Storm Surge is the sum of Mean Max Storm Surge plus Storm Volatility plus Sea Level Rise (due eventually to Global Warming). In Pointe Claire, the Mean Max Storm Surge is 108 inches and the Standard Deviation of the Storm Volatility is 24 inches (assume that Storm Volatility is a RANDOM NORMAL function. You can run and rerun the Pointe Claire simulation in any of 100 random worlds. For the purpose of your first run, you can select the 10th random world by setting the Random Seed equal to 10.

The remaining (advanced) trick for this part of the model is to get Vensim to pick a random normal number with a standard deviation of 24 inches, a mean value of 0 inches, with a minimum value of 0 inches (no negative storm surges), a maximum value of 400 inches (plenty big enough ☺) and a random seed set for world 10. Ask your instructor for help with this equation or see if you can figure it out yourselves by looking at the RANDOM NORMAL function.

Figure 3. Keeping Track of Developed and Undeveloped Acres in Pointe Claire.



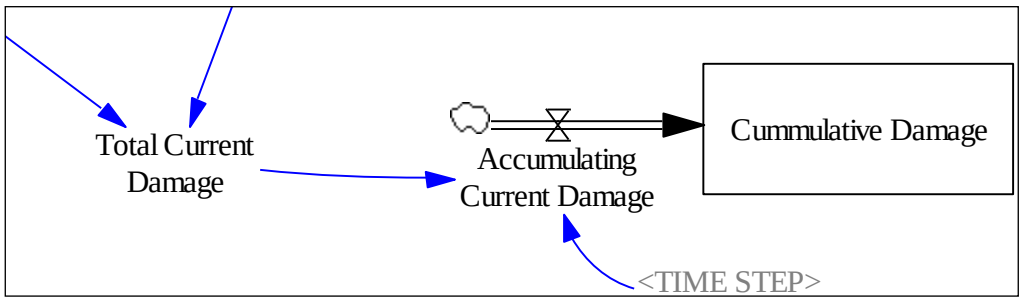
An important determinant of how much storm damage occurs is how many acres have been developed. Think about it, if there is no development at all, then a really bad storm will not cause any damage (to humans and their structures). This simple structure keeps track of how many Developed Acres exist in Pointe Claire. Assume that the model starts with 7500 acres initially developed and with 67,500 acres undeveloped (for a total fixed land area of 75,000 acres). For the moment, just assume that the Reclamation rate is zero (we can change that assumption later on).

Development can be modeled as a Goal-Gap formulation similar to the formulation that we used to keep track of building. Under this formulation, assume that maximum development is 20,000 acres and that the Time to Develop land is 25 years. Your equation for Development should look something like:

$$\text{Development} = (\text{Maximum Development} - \text{Developed Acres})/\text{Time to Develop}$$

Of course in future runs of this model, you could have Maximum Development be driven by some sort of zoning policy and you could formulate an equation to simulate some sort of a land reclamation policy that presumably might be used in conjunction with a zoning policy.

Figure 4. Keeping Track of Cumulative Damages.



The final step in creating a simple, but fully running model is to formulate several equations that can keep track of cumulative damage costs. Conceptually, this is simple. Total Current Damage (remember that is the product of Developed Acres times Damage per Acre for any given storm) is measured in units of dollars per year. So this flow of dollars should simply be accumulated over the full simulation span of the model (2012 to 2052) to get cumulative damages.

Easy enough, but there is a technical Vensim issue to be taken care of. The TIME STEP in this model is 1/8th of a year. This means that Vensim draws a random storm number 8 times each year and calculates damages 8 times per year. We meant for Total Current Damage to be the total amount of damages inflicted by any given storm. But since the TIME STEP for any storm is only 1/8th of a year, the damages accumulate for only 1/8th of a year. In order to get all of the damages accounted for, a Vensim trick is to correct Total Current Damages by the TIME STEP. An equation that could perform such a correction would be:

Accumulating Current Damage = Total Current Damage/TIME STEP

If this equation does not make sense to you, ask your instructor for help—it is a bit tricky.

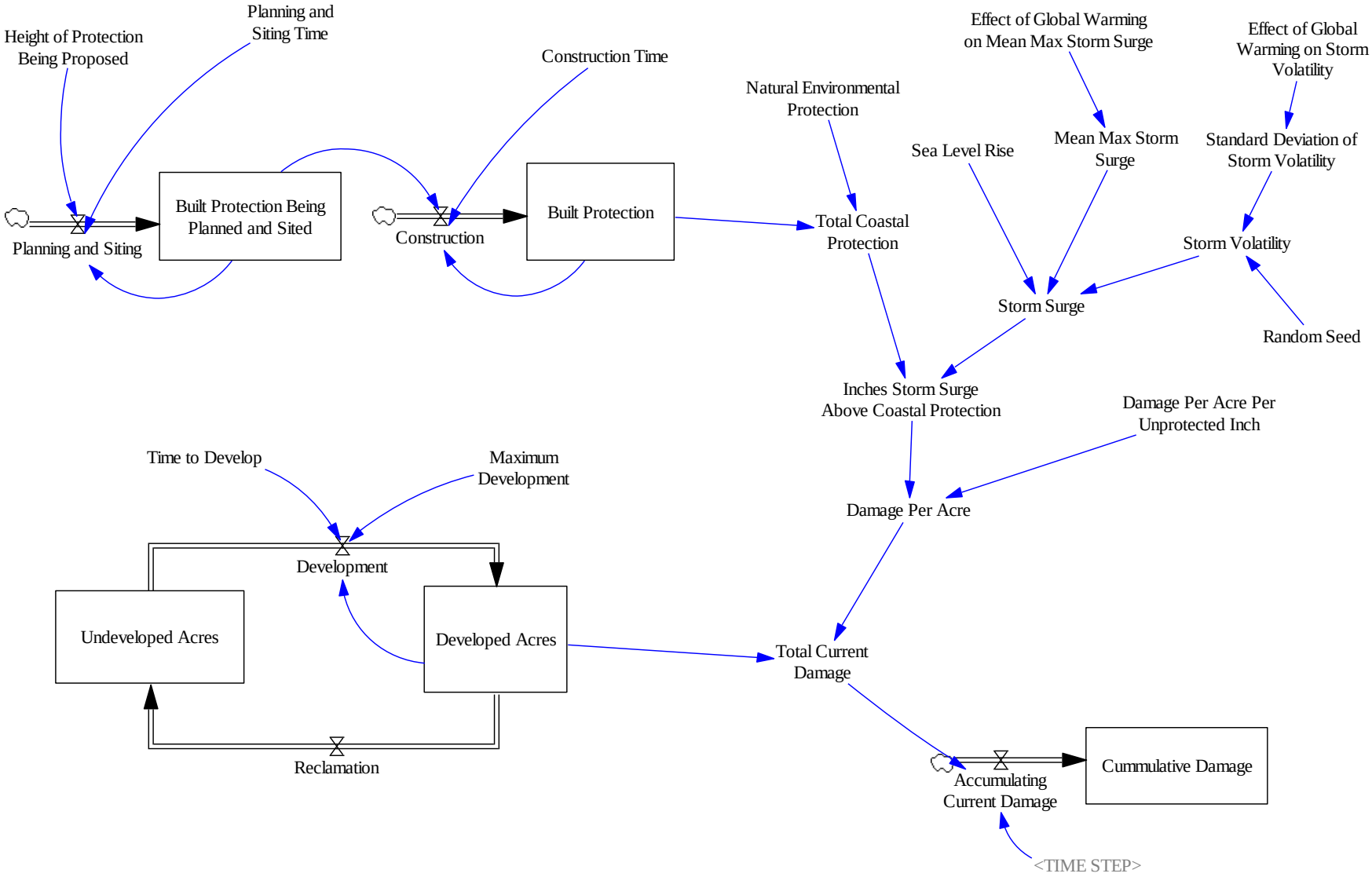
Now if you were being really advanced, you would realize that Cumulative Damage is NOT in Net Present Value (that is the discount rate is zero). Most financial experts and economists would say that this error will lead to an over-estimation of Cumulative Damage. Can you figure out a way to make Cumulative Damage into Net Present Value of Cumulative Damage?

Exercises to Perform on the difference Equation Model for Pointe Claire.

Before you do each of these exercises, you should go to the class Blackboard site and download a version of the model that has been prepared by the class instructors. If each of us used our own model, there might be slight numerical differences between them.

1. **Simulate Different Random Worlds**. Re-run the simulation for three different random worlds as the "Base World" making no other changes. If you make no change to the random seed, the model will run for random world #10. Make re-runs for random worlds #20 and #26. You can call these three runs "Base-World10", "Base-World20", and "Base-World26". Describe what differences you see in each of these three worlds. What is causing the differences that you see?
2. **Build Some Protection**. Returning to Base World 10, re-run the simulation with various levels of built protection. Vary Build Protection in jumps of 12 inches—build 12, 24, 36, *etc.* inches of protection. For Base World 10, what do you infer might be the best level of protection to build? Does this conclusion also hold up in Worlds 20 and 26?
3. **Simulate Some Global Warming.** The version of this simulation up on the Class BlackBoard site has been set up with three parameters that pertain to Global Warming. If you change the variable "Sea Level Rise" (measured in inches) it will make for higher Total Surges (starting right away). The parameter "Effect of Global Warming on Mean Max Surge" is initially set equal to 1 and is then multiplied by Mean Max Surge. So if you change this parameter in re-run to l.15, it will create a 15% increase in Mean Max Storm Surge. The same formulation applies for Storm Volatility. For your first try at simulating Global Warming, assume that Global Warming leads to a Sea Level Rise of 12 inches and a 10% increase in both Mean Max Storm Surge and Storm Volatility. What impact, if any, do these changes in Global Warming parameters have on what you might recommend in terms of Build Protection for Pointe Claire? You should probably answer this first for Base World 10 and then again for Base Worlds 20 and 26.
4. **Think About What We Are Doing Here.** Making all of these runs and re-runs can get complicated. So let's step back and think for a while. As we have discussed in class, "All models are wrong, but some are more useful than others". What is most wrong about this too simple model? What changes might make working with this model more useful to decision makers in Pointe Claire?

Figure 5. A Complete View of the Pointe Claire Difference Equation Exercise.



Appendix B-5: Global Warming and the Pointe Claire Regional Coastal Planning Commission—Part 2

Rockefeller College
University at Albany

Global Warming and the Pointe Claire Regional Coastal Planning Commission—Part 2

(This case and other Pointe Claire case material, maps, and models have been developed by Michael Deegan—U.S. Army Corps of Engineers, Rod MacDonald—Initiative for System Dynamics in the Public Sector, Rockefeller College, and Minyoung Ku and David Andersen—Instructors in RPAD 504 Data Models and Decisions I, Rockefeller College, University at Albany.)

Part I of this case opened with Luz Sansouci facing a number of leadership challenges that arise from her role at the Pointe Claire Regional Coastal Planning Commission (you may wish to reread a copy of Part 1.A of this case to review some of those opening details of the case). As a newly minted MPA from the Rockefeller College hired by Luz to support her work, your first assignment was to provide her with advice on how best to use (or not to use) the C-ROADS climate change policy simulator to support the Commission's policy deliberations.

Since then, we have completed quite a bit of technical work related to the Pointe Claire Case:

1. We have looked at the Pointe Claire situation using formal decision analysis and decision trees as an analytic tool.
2. We have computed the value of both perfect and imperfect information about global warming based on the simplified decision tree in the case.
3. We conducted a mock Group Model Building session that created a system dynamics map of possible causal forces driving policy decisions in the Pointe Claire Region.
4. We worked as a class in the computer lab to convert a simplified map of Pointe Claire, similar to the map that we developed in the Group Modeling session, into a first cut running simulation.
5. We worked with this first cut simulation to observe and study some of its formal properties as a system dynamics simulation model.

This technical work now sets us up to readdress the basic issues in the Pointe Claire case from a more technically sophisticated point of view. *We can seek better to understand how mathematical models can help to support decision making complex situations in the public sector*.

What Has Been Happening in Pointe Claire since Part I of the Case?

While we were busy learning about decision trees, difference equations, system dynamics and group modeling and mapping sessions, Luz and the members of her Commission have been hard at work. Here is what Luz and her Commission have done (H-m-m-m, looks a lot like what we have been doing ☺):

- They have hired a professional team of consultants who have led them through a formal group model building session similar to the session that we went through in class, except their modeling efforts took place over two weekends (separated by three weeks) with additional attention being paid to details of how to get data for the model and how to correctly formulate and parameterize the model.
- The professional team worked between the first and second weekend sessions to create a formal running simulation model. They presented this model to Luz and her Commission at the second weekend session.
- Based on feedback that the modeling team got from team members at the second weekend session, the modeling team updated and refined the running simulation model. The current version of the simulation model has been configured to be able to test the following set of policy options:

    1. Building Protection in the form of barriers, sea walls, and dyke systems
    2. Implementing building codes for more storm resistant construction
    3. Buying out or relocating flood victims
    4. Zoning regulations to prevent development in flood-prone areas

- In addition, the simulation model can test for changes in the following scenarios or key assumptions:

    1. Assumed temperature rise by 2052 from global warming
    2. Assumed Percent Increase in Storm Surge Per Degree Rise
    3. Assumed Percent Increase in Storm Volatility Per Degree Rise
    4. Assumed sea level rise by 2052 from global warming
    5. Assumed discount rate to analyze trade-offs over time.

This model, called the CoastalProtectSIM_V1, was developed by Rod MacDonald from the Initiative for System Dynamics in the Public Sector at the Rockefeller College and Michael Deegan from the U.S. Army Corps of Engineers. The point of this second part of the case study is to help Luz Sansouci figure out how to use this model to support her needs to make decisions and craft policy for Pointe Claire.

Now that she has access to this model, Luz is facing a number of challenging puzzles:

Technical Challenges for Component #1 of this Assignment

1. What is the "story" that the model is telling? This model is quite complex, how can she simply understand its complexity and what it may mean? Does the model have policy lessons buried within in? What are they?
2. What are the strengths and weaknesses of the CoastalProtectSIM_V1 model? As was the case with the C-ROADS and with all policy simulation models, this model is not ultimately and forever "true". But it is the best model currently available to the Commission to support its policy work. The Commission needs not only to harvest the policy insights from the model, they

also need to have a sophisticated understanding of the relative strengths and weaknesses of this modeling effort.

3. What might be "next steps" to improve upon the current model? Once we understand its strengths, but especially its weaknesses, we can propose ways to improve the technical quality of the analysis. This step may involve doing some sensitivity analysis on the model and probing more deeply into where its parameters and data sources are supported.

Policy Challenges for Component #2 of this Assignment

4. Should Luz "roll out" the model in all its complexity to all members of the Commission? To the Public? If so, how should she do this? How much of the technical work that went into the model does she need to reveal to whom and when? What process should she use to manage the release of the model and its results to various stakeholder groups?
5. How can she use the model to communicate complexity to a varied set of stakeholders? Differing stakeholders hold different prior views of what is important and what they want to believe. How can the model be used to communicate that in a complex policy environment it is surely possible that two divergent views of the truth exist, that several views can all be partially correct, but that the whole story may be even more complex that any one of the initial stakeholder views.
6. Can she use the model to mediate possible conflicting points of view and help divergent stakeholders come to a common view of the public good? Is there a common view of what is ultimately "best" for Pointe Claire that most or many of the stakeholders can agree on? Can a complex model help get to such a common agreement based on some shared vision of public value? Can a complex model help to avoid conflict and build a policy consensus?

As described below, this second part of the Pointe Claire case has two components to it both of which are due at Class 12 of this semester's 504 class. That is November 27 for the Tuesday class and November 29 for the Thursday class. Michael Deegan plans to fly in from Washington DC to be present at the Thursday night class on November 29.

Component 1 of this Case Assignment: Technical Policy Analytic Questions.

The first component of this assignment due at Class 12 takes the form of a policy memo and a five minute slide presentation to be given to Luz Sansouci plus two members of the Commission (Youris Sabo and Hanne Daniele). This assignment is a group assignment and should be completed by your study group. The purpose of this assignment is to answer questions 1 to 3 from the above list. To complete this part of the assignment, you will need to run and re-run the simulation model many times and arrive at a "policy package" that you would propose based on what you find from running the simulation model. For the purposes of this exercise, you should assume the CoastalProtectSIM represents the best available consensus model available to the Commission. You initial job is not so much to critique the model as to advocate for a policy position based on runs that come from the model. You may choose to use multi-attribute utility analysis or explicit objective functions (topics that we will be covering soon in this class) to support your analysis. You may wish to identify key sensitive assumptions and parameters in the model and discuss the implications of varying them on the policy package that your propose. For

example, your final recommendations may be sensitive to your assumptions about discount rate used in the analysis, the assumed rise in global temperature or sea level by 2052 or some other assumptions made within the model. When and if you find key assumptions that make a key difference in the technical results that you are presenting, explain how your final recommendations take into account these (often unknown) assumptions. If your analysis finds specific ways that the CoastalProtectSIM model can be improved, you can indicate (perhaps in an appendix to your memo) how this might be done. This is a challenging technical assignment that requires that you and your group come to grips with many analytic and technical complexities both in the Pointe Claire region and its politics, but also in the formal model of these complex issues.

Component 2: Using Complex Analysis to Lead for Policy Change, To Lead for the Public Good

The second component of this assignment due at Class 12 takes the form of a short (2–3 page) policy memo addressed to Luz Sansouci that provides her with specific advice on how to use the maps, models, and analyses that have been developed to support the public policy process in Pointe Claire. This assignment is an individual assignment that challenges you to think broadly about the relationship between Data, Models, and Policy Choice in complex policy environments.. The purpose of this assignment is to address questions 3 to 6 from the above list. In order to do a good job on this assignment, you will want to reflect on and integrate things that you have been thinking about and reading about in other core classes in you MPA program.

Ultimately Luz Sansouci's job is not to simply arrive at a best technical solution to a complicated problem. As a leader in the public sector, her job can be seen as providing leadership for the "public good", finding ways to promote public value in her community. Fung (2003) envisions these functions in terms of designing "minipublics" that vary along dimensions of the character of participation and deliberation, how information is pooled to channel and change citizens' minds, how notions of popular accountability and control interact with capacity of the state, and finally the political effects of policy changes and proposals. According to Fung, Luz needs to figure out how to use these model-based analyses and insights to help her better to design her minipublics that will make Pointe Claire a safer community in the long run. Eden and Ackermann (1998), taking a point of view similar to Fung view the development of public strategies as gaining alignment and consensus between and among major stakeholder groups in the public arena as the key task of the leader in a public policy setting. They explicitly view complex computer-based models and the group sessions that are used to create and understand these models as opportunities to expose points of conflict between various stakeholders and to build toward a consensus view of a problem that has the potential to transcend parochial points of view of any given stakeholder group. By involving all key stakeholder groups in the modeling process Eden and Ackerman view complex models as a way to gain agreement about a strategy for moving forward in the face of complexity. Senge (2006) argues along a similar line that the work of leaders in the 21st century is to build alignment among members of a strategy team through a process of shared vision and team learning that is capable of creating "learning organizations". In Senge's view, creating whole system views such as the maps and models that have been developed for Pointe Claire is the key to aligning mental models and coming to a shared vision of how to move forward for the public good. Senge would be interested in having Luz gain alignment on the Commission by using her system maps

and models to create and then promote a whole system view of the problems and issues facing the Pointe Claire Community. All of these scholars are concerned with questions 3–6 in the list of challenges above that face Luz as a public leader.

Your individual assignment for this second component of this case assignment is to craft a short (2–3 page) executive memo addressed to Luz Sansouci advising her on how to use the maps and models that have been created to lead for the public good in Pointe Claire community. Luz is seeking specific suggestions for how to link that technical model-based analysis that the Commission has done to a more complete public policy process. In answering questions #3–6 above, what specific recommendations would you give her (1) for "rolling out the model", (2) for using the model, maps, and other technical analyses to communicate how complex and inter-related are the policy choices in Pointe Claire, (3) and using the model and other technical analyses to mediate conflict and arrive at policy outcomes that to the extent possible are guided by a genuine view of the public good, not just special interest positions.

This is a assignment that seeks to summarize much of what is important to this class on Data Models an Decisions and challenges you to think through specifically how models, especially complex policy-oriented models should best connect to the public policy process. The readings cited in this case study are also assigned readings in other core classes in your MPA program—this assignment is pushing you to think across categories of our MPA core curriculum. Of course, we will have opportunities to discuss this assignment in class any time that you wish (well, almost any time) between now and its due date at Class #12.

Good Luck!!

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