



Social-Hydrological Risk in the Mexico City Basin

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STUDENT HANDOUTS



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ACKNOWLEDGEMENTS

The case is based on the MEGADAPT project, an National Science Foundation-Coupled Natural Human Systems project *Grant No. 1414052* entitled *The Dynamics of Multi-Scalar Adaptation in Megacities* (PI H. Eakin):
<http://lancis.ecologia.unam.mx/megadapt/>.

This case development was supported by the National Socio-Environmental Synthesis Center (SESYNC) under funding received from the National Science Foundation DBI-1052875.



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MODULE 1: SES AS COMPLEX SYSTEMS

INTRODUCTION

It was 4pm when Georgina heard the bell rung at the end of the alley. She grabbed her rubber boots and climbed over the raised threshold at her front door – her attempt to keep the waters out -- and stepped down into the black, smelly water that was now a few inches deep in the alley. Joining her neighbors in the pouring rain, and admonishing her children to climb up on the kitchen table, she hurried to the end of the alley where the pump was located. Reaching into the drain, now clogged with garbage and silt, with her bare hands, she pulled out the tube to clear the end of the pipe of garbage. Her neighbor, Luz, flipped the switch and the pump started up. Slowly, slowly, they watched the water begin to move down into the sewers. This time they were lucky, the filthy water did not enter any home. Nevertheless, she was thankful that she had raised her stove up on cinder blocks after the last time they were flooded. The stove was one of her more valuable possessions.

Meanwhile, in the community of Miravalle, perched on the hill just 600 meters above Georgina's residence, Lupe was dumping buckets of water she was collecting from the downpour into a 50 gallon "tambo." She was grateful that as a result of the storm she was going to have enough water to meet her needs for laundry washing over the next few days. Where she lived, her water supply was intermittent -- she typically received water only twice a week, for a couple hours, in system of water delivery called "tandeo". And the quality of the water was typically horrible: "tamarind" color, and often smelly. While she had limited space and capacity to capture and store the rainwater they received, the extra gallons she managed to collect during the storms would be make a big difference. Unfortunately, such rainfall events were concentrated only in a few months of the year. For the dry season, she was forced to "find" water -- typically buying water from private suppliers who come to the neighborhood with tanks.

In a third floor office in the center of the city, Manuel, the director of the new Resilient Cities initiative for Mexico City, watched the rain with increasing preoccupation. In an hour, he was to meet with his staff to discuss how they were going to address the problem of water scarcity and flooding through the project. Where to start? Who should be involved? He was a bit overwhelmed by the complexity of the problem. He was determined to involve more than the staff of the environment ministry in which his office was located, but getting the other sectors on board and committed was a challenge.

Managing water excess and scarcity is one of the foremost challenges for society this century. This challenges are exemplified in Mexico City, a megalopolis of 22 million and one of the world's largest urban areas. The city was founded in 1325, improbably located in the center of a series of shallow, saline lakes that at that time covered the Valley of Mexico. For over 600 years, catastrophic flooding and access to potable water have challenged the city's residents, motivating extensive investments in hard infrastructure to supply the city with fresh water, or to protect the city from periodic flooding. Perplexingly, the ways in which city managers and residents have responded to the challenge of water in the city have both enabled the city to thrive, while

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simultaneously creating conditions of pending crisis via subsidence and over-reliance on fallible infrastructure. With each successive investment, water systems have become less sustainable. Today, all residential and industrial wastewater (only 8% treated) is combined in the same infrastructure as storm water and pumped out of the Basin through the *Gran Canal* and the “Deep Sewage” system (*Drenaje Profundo*). Both systems were designed to operate with the help of gravity, but increasing land subsidence now requires fuel-intensive pumping to drain sewage and flood water. Today half of the city’s freshwater is pumped from an overexploited aquifer below the city and the other half via interbasin transfers from adjacent watersheds (Lerma and Cutzmalá) at increasingly high economic and ecological costs. Even though much of the population does not have adequate access to potable water or sewerage, very little water is recycled or reused. Over the last century, land speculation, political incentives, and deregulation have forced newcomers and the poor to the urban fringe. Urban settlements, land-cover change, and ecosystem degradation have impacted the southern ecological conservation areas and upland watersheds, creating increasing runoff and exposure to hydrological hazards downslope. Localized flood events impact transportation routes, commercial activity, public health, and property. The chronic nature of the problem raises the specter of increasing vulnerability under a changing climate. Vulnerability in this context is a product of complex socioecological system (SES) dynamics, rather than a simple aggregation of the sensitivity, exposure, and capacity of a city’s neighborhoods, businesses, and institutions. In Mexico City, as in many megacities, risks are addressed in fragmented and sectorial ways: one dimension of risk is prioritized over others, tradeoffs among risks are ignored, and adaptations can, over time, exacerbate vulnerability, rather than reduce it.

Introductory Video Links:

PBS News Hour, November 10, 2014 “Mexico City Faces Growing Water Crisis”.

<http://video.pbs.org/video/2365366376/>

Altman, L. November 12, 2014. “Water, water, nowhere. Mexico City endures severe shortages.” *Nonprofit Quarterly*. <http://nonprofitquarterly.org/2014/11/12/water-water-nowhere-mexico-city-endures-severe-shortages/>

Baverstock, A. June 2, 2014. “Miserable flooding is a fact of life in Mexico City’s impoverished borough. *Vice News*. <https://news.vice.com/article/miserable-flooding-is-a-fact-of-life-in-mexico-citys-impoverished-borough>

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Exercise 2

On the basis of what you've learned on creating causal loop diagrams, represent what you know about Mexico City's water challenges in system terms. A causal loop diagram is a form of systems model, illustrating the connections between different elements or variables in a system. A variable is an entity that has values that change (increase/ decrease) at different rates. Causal loop diagrams represent how you, or any other actors, perceives the relationships among system elements – in other words, how different variables influence changes in other variables and at what time scales.

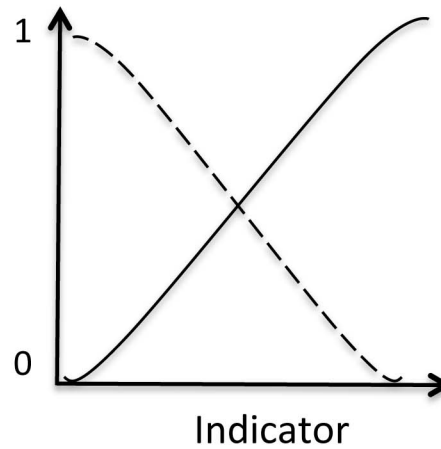
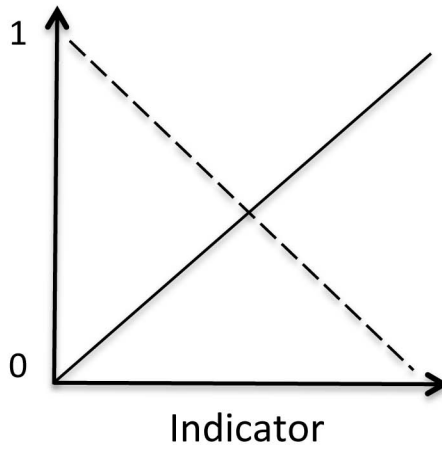
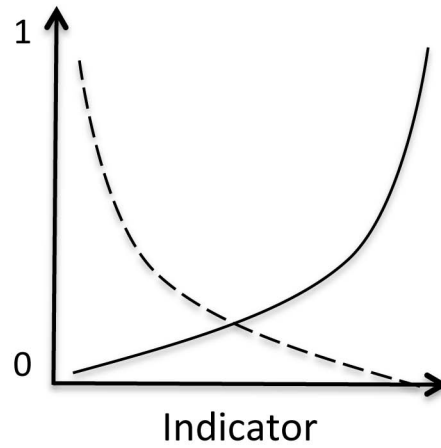
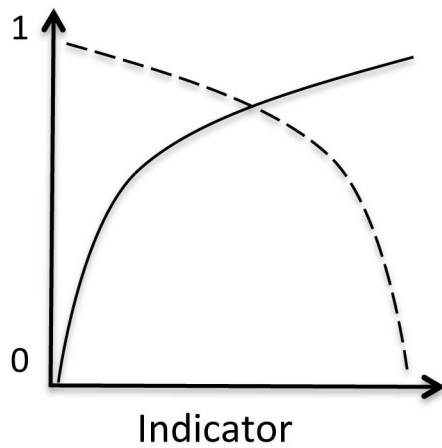
To make your model of Mexico City's water challenges, follow these steps:

1. To make your diagram, use MENTAL MODELER a freely available software:
<http://www.mentalmodeler.com/online/>
2. Select "Add Component" at the top of the screen. In the box that appears, insert the name of the variable you want to start with. Repeat with all the variables in the list above until all are represented as text boxes on the screen.
3. Put your cursor over a variable and you will see that an arrow appears at the bottom of the text box. You can then pull the arrow to another text box, indicating that the first variable directly influences the variable you are connecting it to.
4. The software will then prompt you to indicate whether the relationship is + or - (don't worry about the options of ++ or +++ etc., just indicate whether it is a + or -).

Remember, a "+" indicates a *positive polarity* in the relationship between the variables: when there is an increase (decrease) in the value of the first variable, it generates an increase (decrease) in the value of the second variable, all else being equal.

A "-" indicates a *negative polarity* between the variables: when one variable increases, the second decreases (or vice versa).

- 5) Reflect on the possible existence of feedbacks among variables. Would these feedbacks be self-reinforcing (positive; or "more leads to more" or "less leads to less")? Or "Balancing" feedback loops (i.e., "more leads to less" or "less leads to more")? Are there temporal delays in the feedback relationships?
- 6) Note any hypotheses that you have about the variables you've described in the diagram in the annotations to the model.
- 7) Take a screen shot of your diagram and SAVE IT on your computer [Option on the top right of the screen].



Possible representations of variable dynamics.

Derived from : Alarcon, B.; Aguado, A.; Manga, R.; Josa, A. A Value Function for Assessing Sustainability: Application to Industrial Buildings. Sustainability 2011, 3, 35-50. (Open Access: <http://www.mdpi.com/2071-1050/3/1/35#stats>)

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Module 1, Day 3

HOMEWORK (Group assignment)

As a final summative assessment, each group will turn in the following:

- 1) Master Model (causal loop diagram) of Mexico City's water challenges, represented as a social-ecological system
- 2) Table of variables (composite table from Day 2's homework incorporating contributions of all group members):

Variable	Current state of variable and data source	Trends in variable and data source	Spatial scale at which this variable is observable	Temporal scale of observation of change	Type of dynamics in variable (value function) -- monotonic, non linear, etc

- 3) Narrative (~ 1500 words): Using the Master Model and accompanying table as your sources, present and justify a strategy for intervening in the system to address what you have decided is one of the more critical aspects of the social-ecological interactions in the system. Describe how your strategy addresses the dynamics of the system and the challenges posed by differential time and spatial scales of problem causes and outcomes.



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MODULE 2: HUMAN AGENCY IN SES

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Module 2, Preparatory Activities

In preparation for Module 2, Day 1

1. Read the following information/articles:

- Revisit: Carrera-Hernández, J. 2006. Interim Report IR-06-022 Mexico City's Water Management: In search of sustainability.
<http://webarchive.iiasa.ac.at/Admin/PUB/Documents/IR-06-022.pdf>
- Revisit: Tortajada, C. & Castelán, E. 2003. Water Management for a Megacity: Mexico City Metropolitan Area. *AMBIO: A Journal of the Human Environment* 32(2): 124-129. <http://www.bioone.org/doi/abs/10.1579/0044-7447-32.2.124>
- Stakeholder Analysis (World Bank)
<http://www1.worldbank.org/publicsector/anticorrupt/PoliticalEconomy/stakeholderanalysis.htm>
- Stakeholder analysis: a review (Brugha and Varvasoszky, 2000)
http://www.sihealthpolicy.org/wp-content/uploads/2013/06/stakeholder_analysis.pdf
- Using stakeholder analysis to increase the effectiveness and relevance of water resources systems modelling (Hermans, 2001)
http://hydrologie.org/redbooks/a268/iahs_268_0183.pdf

2. Take 20 minutes to write down answers to the following questions:

- What is a stakeholder/actor?
- Why (what evidence)?
- Who are the stakeholders in MC SES?
- What SH categories do we have?

3. Create a preliminary list of stakeholders from readings

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Module 2, Day 1 HOMEWORK

In preparation for Module 2, Day 2

1. Read Jones et al. 2011 and Cone and Winters 2011.
2. Take 15 minutes to write down answers to the following questions
 - What is a mental model?
 - How can understanding mental models provide insights into SES interactions?
 - How can interviews aid in eliciting mental models?

Module 2, Day 2 HOMEWORK

In preparation for Module 2, Day 3

You will be assigned one interview transcript of an actor in Mexico. These transcripts are based on real interviews; the content of the interview has been modified to ensure that identities are masked completely. These interviews were conducted or commissioned by the authors of the case study (H.Eakin, L. Charli, B. Tellman, and A. Escalante) with full Human Subjects approval from Arizona State University.

- Flooded resident
- Disaster management official
- Local urban planner

Read the interview transcript and record each core concept mentioned by the interviewee as part of their vision of the water problem in Mexico City as a variable in Mental Modeler (<http://www.mentalmodeler.com>). Illustrate the relationships among the variables as described by the interviewee by arrows. You can test the validity of the arrow according to the interviewee's description of the relationship by "reading" the relationship, for example, between variable A and variable B as "Variable A *influences* variable B" (or a change in variable A *causes a change* in variable B).

Save your version of the mental model on your computer and bring it to class.

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“Disaster Management Official” Mexico City Interview Transcript 1

Well, to me it seems that first of all population growth with its associated property, housing, transport and, unfortunately, also the combination of industry – we still have industry here and within the industrial sector there are big consumers, for example, of water – the beverage industry – well, yes, I think they are demanding too much from the Valley of Mexico. I think that the primary problem would be water supply; we’re bringing it in now... we’re bringing it in from other places although it is true that we are still extracting the majority of our water from our aquifers, and this also provokes other problems.

So, I don’t see that it is slowing down, or that we want to slow down, we’re slowing down because there isn’t space... the space that remains available is very, say, creates a lot of risk for population, because it is this land that is being occupied little by little. And the land that is allocated for preservation is also being surrounded and on occasion invaded; so I don’t see very clearly any way that its going to slow down – and perhaps it will even gain speed, no? We’re building more roads for cars, permitting high rises -- we see them here in Mexico City despite this being an area of seismic risk, it isn’t preventing construction...

So I don’t know what is the real enemy, is it resource scarcity or the local government that is taking risks with a strategy that strains the city’s capacities? I have heard that a few NGOs want to, for example, return the city to the way it was before, for example, in the city center return to having lakes. But these have been really just ideas, as projects they haven’t prospered. But there is that voice, I believe that a part of society expresses the idea of having, if not returning to a historical scenario here in the city.

We’re worried because the population that comes from other states settles here in Mexico City, or even from other countries ... such that they come without full knowledge of the area. So it is a very vulnerable population, both socially and physically. The construction of housing that they improvise leaves much to be desired in relation to earthquake risk, and in relation to hydro-metrological risks and extreme events, whether extreme winds, temperatures, rain or hail.

There are not only problems of quantity but also quality of water. The quality of water that comes from Cutzamala is very good and enters the city through a distribution mechanism, but it doesn’t get to all of the city. The rest is again from wells, and it is there that I think there is a grave problem. Well, maybe not grave, but it is a problem in terms of the quantity of sediments that the Water Secretary here in the city has to take out... even sometimes toxins -- and moreover to keep the water potable. Here we have to remember that we receive water up to the household, but at that point it is the household that has to keep water in good condition, and the truth is that doesn’t happen.

It’s a cultural problem, we have our famous water storage tanks, but instead of become a strategic element in household health I think they forget to maintain them... and thus these same tanks become the site of certain diseases. Curiously... we consume a lot of bottled water.

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It's a bit strange, I think it is a lack of simple understanding; the population should have the capacity to at least maintain its household storage tanks and cisterns in good condition...

The water that arrives at the houses is potable but there is a psychological barrier, even a bit of distrust... but in general the contamination emerges because of lack of maintenance.

The distrust emerges because of the same water bottling plants, although they don't say it directly, but implicitly the message is that if you aren't drinking bottled water it is contaminated. And here the government should probably intervene more and mention that the water is potable, and shouldn't be wasted by the population as only a source for washing but rather for drinking.

What we've seen is that in the case of a big earthquake the part of infrastructure that is particularly sensitive is precisely our large diameter pipes that carry the most water. These fail, they break; so when an earthquake occurs the first thing that happens is a cut in water supply and from there begins a chain reaction. It's also because our peculiar soils here in the Valley, is very flexible, so perhaps we should be thinking about adapting our infrastructure to the type of soil we have here, which is suffering from subsidence and particular forces when earthquakes provoke fractures, and it is then that the water supply interruptions occur. Basically, there is water, but when an earthquake occurs the supply is interrupted because the vulnerability of the large diameter pipes.

In a very incipient way there are interventions now to capture rainwater, and in certain places in the city real rainstorms occur, so that rainwater collection really could be a big solution and would have two benefits: first, it would compensate for the lack of water and the water that we would store and keep in tanks would allow a diversity of uses, except for human consumption; but the other is that during the storms the collection of rainwater would help regulate the risk of flooding, if it were generalized, if every household collected a certain quantity of water, because in the end although it may not be a big percentage but it would free our storm water and flood control infrastructure from becoming saturated. In fact, the city has already begun to identify some sites as storm water reservoirs to store water during storms, and then when the storms finish allowing the water to slowly integrate into the drainage system, but the effects still have to be seen and it isn't yet the norm... and even less common but you do hear that a few people have houses with – what do you call it? – they plant vegetables on their rooftops.

The water reservoirs are interventions of the city government. It is an ambitious plan to dedicate areas to regulate water, in different parts of the city such as Chalco, between Xico and Tláhuac, in the State of Mexico and in the Federal District. In fact, there is already a water body there; the other body of water is Xochimilco, which in one way or another also serves as a regulating reservoir....

Around Xochimilco there are still a lot of areas of houses and wetlands, so it is there that they're adapting, we'll say, its there that there are reservoirs, in these areas there are even small dams. So, where there were once wetlands there are now retention walls, the already constructed infrastructure and there are pumps; so they're sending water that they are collecting in the urban zone to these areas...

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The other option I've heard nothing about – and perhaps it is my lack of information – but I've heard nothing about groundwater recharge through injection; I know it is really difficult because of our soil types and for that reason perhaps not really viable, from an economic perspective, but if we have a rocky area... perhaps it could become feasible...

I believe that, as I've mentioned before, I think that flooding is not the problem that we heard about some ten or fifteen years ago, that we even saw as something apocalyptic, like something that would turn the city again into a lake. I think that the problem has diminished a lot. We were afraid because the deep drainage system for the city hadn't been adequately maintained, so we sent in a robot—because it is difficult to get down there – and we saw that part of the concrete was severely damaged—but I think they sent the robot to the most critical area; beyond that site the tunnel was in good condition and now they've built another tunnel, the TEO, and other public works in addition, such as the regulating reservoirs, which all make me think that the probability of a catastrophic failure in infrastructure has diminished, of course there are localized failures, but the city is now divided by sections, such that you can isolate an area and solve local issues independently.

Most of the city is already urbanized, so we don't have surface water flows anymore, and the few remaining surface water flows such as Viaducto and Río de la Piedad, etc have been enclosed, so now they work in relation to valves and sluices, and pumps, so this way a flood in an area can be controlled by closing sluices. Moreover this allows one area to be flooded in order to control the flood, preventing in this way a larger more generalized flood.

It's very common, for example, two years ago it flooded – it is difficult that the government would admit to this maneuver, so it is more mentioned as a problem of lack of drainage, or that the population throws garbage in the drains, all true things. But two years ago there was a flood that affected housing complexes and everything, but it was with the purpose of not permitting a more expansive flood event.... So in part yes, it is because infrastructure does fail, but it is also to make sure that the flood doesn't saturate the rest of the system; it is preferable to flood one sector of the system than saturating the system and flood a larger area.

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“Flooded Resident” in Mexico City Interview Transcript 2

We arrived here out of necessity in '85 [after the earthquake], many of us were left without housing; here before there was grass, like corn fields, and water, they tell me, here there were people who came out to have a day in the country and there was a lot of water they say. Not a lake, more like canals, it wasn't clean water.

We created a settlement here, the called us “cardboard land” because our houses were of cardboard, although with time we built of concrete but everything was provisional. We weren't allowed to build formally.

Today we have here 504 families, and in the other housing unit there are 1000. With a lot of work and savings we organized ourselves, and today the Organization still persists. Today is isn't only housing that we demand, but rather salary, better transport, better health services, better [access] to all the basic necessities that we know exist in the country, because Mexico is a rich country, it's beautiful what we have here but there are just a few that benefit from it.

We knew that here there was land and we came and learned to pick up the shovel, the pick and the wheelbarrows... To save on the labor, we provided it ourselves so that the budget we were given [by the public housing authority] could be stretched further.

We installed the services when we began to build here... we knew that there was water below the development because as I said, there were canals, and thus if we excavated a lot of water came out. We put no more than three levels on the houses because we knew that there was a soil study that analyzed how much the soil could support. They said no more than three levels. And he told us that there was water here.

All the corresponding departments in the delegation offices gave us services; the only thing they put in new was sewage but the sewage was insufficient because it was connected to other neighborhoods and today it is affecting us. When it rains the water begins to overflow the drains because there are more neighborhoods connected to the network. It is like being in the middle of two rivers; two years ago the water entered up to here [gesture], I remember that I couldn't walk because the water made me feel faint, so I retired from the scene, first because I didn't know what to do and it made me feel afraid. We have a problem that the drainage is insufficient. We asked the mayor to connect our neighborhood to the deep drainage system but he said that it was very expensive. But I think that human life is worth more, and we are living in constant danger here, if the canal overflows I don't know what will happen.

The neighborhoods began to connect to our drainage network, so when it begins to rain here, logically it brings in water from other neighborhoods, and because [the infrastructure] isn't sufficient now to exit, the water begins to come out of the drains and here in the Molino I understand that the whole area is subsiding, for example there were neighborhoods and gardens here that never flooded and today there are large puddles, it floods, but the problem is more in our area... as I told you, we did this, because one day we woke up and the water was inside the house. The helicopters came because it was flooded outside and for this reason most of us here on the ground floor have put these concrete barriers at the entry of our homes.

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We realize that starting about 3 or 4 years ago it is flooding more, for example, before this block didn't flood, the water didn't come in and today the water runs right by here

We asked the water people and the National Water agency to address the issue but they always tell us that they lack resources but I say instead of spending in other things they should focus on the needs of the community. The mayor said it was a costly investment, but how many mayors come and go? And it is here in our borough where they give us a budget much bigger than many state governments. So I say the money is there, but no, they don't want to spend it or they are waiting to see what will happen, waiting to find people drowned.... Like I told the last mayor, is that what it is going to take, finding us floating here in order to take some action. It isn't just here where there is a problem, but I have to fight for where I live.

We send petitions but if they don't pay any attention it is necessary, well, we hold a march, a protest or a sit-in so that they really see ... At that time we'll enter in negotiations, they'll give me dates and if they don't comply we'll move and request that he sign a commitment with us, and if they don't comply then we'll organize a boycott again and won't move until they give us the service we request. Each year we do 4, 5 mobilizations. Here we say that if the people don't organize, if we aren't united and organized, the government won't take us into account. If I go as a simple citizen and I say I want housing because the Constitution guarantees me housing, do you think they'll give it to me? They won't. So that is why we organize together, united to achieve things.

Now it isn't necessary to do this because here when it begins to rain right away the (local government engineer) calls and ask how things are. Sometimes our cisterns are contaminated because sewage enters. For that reason, we've put these barriers to prevent the sewage from entering

When it rains we start up the pumping stations and the water begins to diminish in the areas where it is most critical, like there where it is a bit lower in elevation. We have to let the water levels decline slowly, slowly because if we try to pump too fast it could overflow and make things even worse. We're in a very risky area... Sometimes it takes three hours to go down... and starts backing up in the house drains and you have to be on the alert and mopping up so that it doesn't come in.

So I go out and begin to ask the neighbors, is your cistern contaminated? Because if it is then they have to come and clean it and get rid of the water that is now contaminated. Then the Delegation comes and they wash all the sidewalks because of all the filth that comes from the drains, the dirt, the garbage that comes from the pipes. They wash everything down with hoses.

We've asked them to create a drain or reservoir but I know it isn't the solution. For me it really is a palliative, to tell you the truth they could create all the drains they think are necessary but who can guarantee that we won't be flooded? For that reason, we've argued that if you are going to spend I don't know how many thousand pesos or millions... well then at least the federal, local and delegation governments and everyone should get together to give us a real solution.

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Urban Planner, Iztapalapa, Mexico City Interview Transcript 3

“... We still have a way to go in terms of building the potable water network, sewage system, and areas for absorbing and infiltrating rainwater. Because this is something that happens. All the water goes to the central drainage canal; it isn't retained in the area, it isn't absorbed. For this reason, it is drying up here. The geological layers are becoming fractured and there now are cracks in the surface. This is another problem we have here... the cracks and fractures are affecting our development and public spaces, the schools for example. There is a school that is sinking in the northern part because there is a large crack and it is tipping down one side. There are also public housing units that are being affected by the fractures and this is becoming a housing problem now in addition to problems of public services such as the potable water, drainage, infiltration wells... and we still lack paved sidewalks. Our green areas are really deteriorated as well.

Mexico needs to build vertically now. We don't have the space to build houses, we're invading every available area. Soon there won't be a pine tree left on the slopes of the watershed... And in addition to building vertically, we need to have sustainability projects. For example, if you are going to construct 500 apartments, then you need to provide 300 trees... but I don't see that we are talking about any ecological improvements. There isn't anything that says “Where is your cistern? How are you going to capture rainwater? Where is your local treatment system so you can use that water for drinking or for sanitation or irrigation?”

Mexico City grows without any order, and thus the surrounding hillsides are completely invaded with irregular settlements. Now they've invaded federal land as well, where there are ecological reserves and where once was the Texcoco Lake. So all the water flows from the hillsides to the city, for this reason it creates a lake. This is what happens when Nature is charging you for what you took away from it. For this reason many housing developments flood all the time. Because all the water from the regions flows down there ... they shouldn't have built where the Texcoco Lake was. All that area was formerly a landfill... and before that, the lake.

The flooding is caused by a lack of applying best technology for rainwater capture: capture it, absorb it, don't waste it. All the water that flows into the city leaves it – it shouldn't be that way – it should be retained here, not leave. The second cause is garbage: the drainage system is not capable of managing the volume of water and garbage. When it rains intensely and the pipes are not able to drain the water fast enough they clog with garbage. Many people throw garbage – it is particularly a problem with the open food markets. If you come by the day after the market you'd see the garbage dump they leave. You can see the disorder with which they manage garbage. Unfortunately, we are not cultured to have our own garbage bag and carry it with us. Well you know the problem...

Also something that I see here that I don't like is that many people complain about the trees. They say that the trees break up the sidewalks. Some of them cut the trees down without permission. They don't participate in caring for the green areas of our neighborhoods.

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The local borough governments are only in power for three years at a time, so this doesn't give a lot of time to organize. It is a political problem we have. So there also isn't really any urban planning or map. This plan is what is most important. Because if a new borough president arrives without a plan, he or she will go inventing one. She or he will construct a palace where there shouldn't be one. They need to be sticking to the budget, investing in the community, but they go on inventing..."

Module 2

Final Summative Assessment: Homework

Objective: Synthesize understanding of the relationship between actors’ mental models and SES dynamics.

Using the accumulated material of the modules 1 and 2, you will propose an intervention that would most likely to be associated each of the three interviewed stakeholders’ mental model and influence. For example, you might suggest “reforesting the watershed” as an intervention associated with a peri-urban natural resource user, or “increasing the infrastructural drainage capacity” for a water manager. You would then describe how that intervention affects the dynamics of the SES, drawing from your understanding of the stakeholder’s individual mental model, the master model, the stakeholder analysis and the background materials provided for the case study. Your final product will be approximately 3-4 pages of text, plus a copy of the master model tracing the influence of the different actors. You should draw explicitly on the interview data, the stakeholder analysis and the background material as part of your analysis.

Rubric

	Poorly executed	Proficient	Excellent
Analytical Content	Text demonstrates poor understanding of theory and concepts associated with mental models. Hypotheses of influence of actor over system is poorly substantiated with background materials, stakeholder analysis and/or interview data.	Text demonstrates adequate understanding of concepts, although lacking depth and analytical insight. While further support and justification for analysis of stakeholders’ influence could have been provided, the analysis demonstrates adequate understanding.	Text demonstrates mastery of concepts and theory presented on mental models, stakeholder analysis and SES dynamics. The propositions concerning stakeholder influence in the system are well-supported by the background material, stakeholder analyses and interview analysis.
Organization/ Completeness	The text is poorly written and organized; lacking synthetic vision. References to background material are not appropriately cited.		The text is well-written, clearly organized and demonstrating a capacity for comparison and synthesis as appropriate in the introductory and conclusion statements.



Social-Hydrological Risk in the Mexico City Basin

STUDENT HANDOUT

**MODULE 3: VULNERABILITY, RISK AND
RESILIENCE**

Social-Hydrological Risk in the Mexico City Basin

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HOMEWORK

In preparation for Module 3, Day 1

Read the following articles and consider what vulnerability means in relation to risk. Start with the conceptual articles, then read the article on Mexico City, annotating it with key themes you found in the conceptual readings. Note any questions you might have.

Conceptual readings

- Turner BL, Kasperson RE, Matson P a, et al (2003) A framework for vulnerability analysis in sustainability science. *Proc Natl Acad Sci U S A* 100:8074–8079. doi: 10.1073/pnas.1231335100

Reading related to Mexico City

- Romero Lankao P (2010) Water in Mexico City: what will climate change bring to its history of water-related hazards and vulnerabilities? *Environ Urban* 22:157–178. doi: 10.1177/0956247809362636

Optional Readings

- Turner BL, Matson P a, McCarthy JJ, et al (2003) Illustrating the coupled human-environment system for vulnerability analysis: three case studies. *Proc Natl Acad Sci U S A* 100:8080–8085. doi: 10.1073/pnas.1231334100
- Eakin H, Luers AL (2006) Assessing the Vulnerability of Social-Environmental Systems. *Annu Rev Environ Resour* 31:365–394. doi: 10.1146/annurev.energy.30.050504.144352

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IN CLASS ACTIVITY

Module 3, Day 1

Exercise 1: Plenary Brainstorm Table

Vulnerable group	Biophysical Exposure	Social Condition (Sensitivities, Capacities)

Exercise 2: Master Model Analysis Questions

What are drivers of each form of vulnerability? Are there relationships of variables that are reinforcing patterns of vulnerability? What would be needed to change these relationships (how to break positive feedbacks with adaptations?)

Be prepared to discuss how intervention to address one part of the diagram could affect others.

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HOMEWORK

Preparation for Module 3, Day 2

Read the following articles and consider the difference between vulnerability and resilience. Note any questions you might have.

Readings:

Brien KO, Sygna L, Haugen JANE (2004) VULNERABLE OR RESILIENT ? A MULTI-SCALE ASSESSMENT OF CLIMATE IMPACTS AND VULNERABILITY IN NORWAY. *Climatic Change*. 193–2

Eakin, H.; Tompkins, E.; Nelson, D.; and Anderies, J. M. (2009) Hidden costs and disparate uncertainties: Trade-offs involved in approaches to climate policy. In N. Adger, I. Lorenzoni, and K. L. O'Brien (Eds.), *Adapting to Climate Change: Thresholds, Values, Governance*, (pp. 212-226). Cambridge: Cambridge University Press.25.

Optional:

Lebel L, Garden P, Imamura M (2005) The politics of scale, position, and place in the governance of water resources in the Mekong region. *Ecol Soc*. doi: 18

Turner II, B. L. (2010). Vulnerability and resilience: Coalescing or paralleling approaches for sustainability science? *Global Environmental Change*, 20(4), 570–576. doi:10.1016/j.gloenvcha.2010.07.003

Moss T, Newig J (2010) Multilevel water governance and problems of scale: Setting the stage for a broader debate. *Environ Manage* 46:1–6. doi: 10.1007/s00267-010-9531-1

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IN CLASS ACTIVITY

Module 3, Day 2

ACTOR:

INFLUENCE:

PROBLEM	Intervention	Adaptation/Mitigation	New Vulnerability	Evidence to test the relationship

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HOMEWORK

In preparation for Module 3, Day 3

Download Netlogo:

<https://ccl.northwestern.edu/netlogo/>

Complete Tutorial one: Models

<https://ccl.northwestern.edu/netlogo/docs/>

Read the ODD of the model:

- White paper on model results and ODD description of the model
- Go to: <https://www.openabm.org/model/4907/version/1/view> → download risktransferresults.pdf and risktransferODDv1.pdf

Read this article

Janssen, M.A. and E. Ostrom (2006), Empirically based agent-based modelling, *Ecology and Society* 11(2): 37. [online] URL:

<http://www.ecologyandsociety.org/vol11/iss2/art37/>

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Student handout

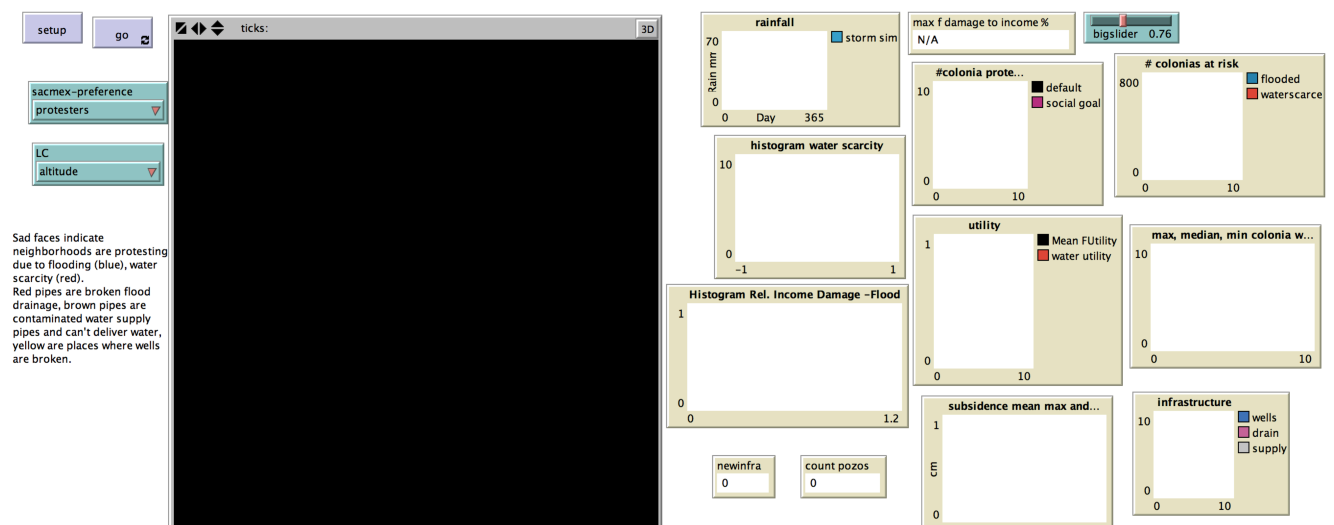


IN CLASS ACTIVITY

Module 3, Day 3

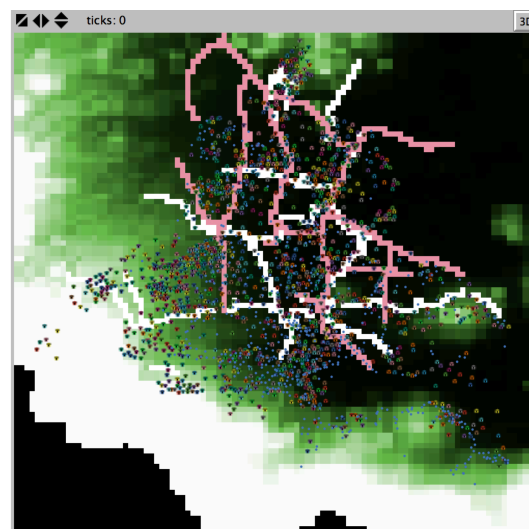
Handout of instructions to open and run ABM. You will need Netlogo running on a laptop for this to work.

1. open the file risktransfer2_16.nlogo
2. you should see a screen like this:



Make sure you know what all the plots and monitors mean. Refer to the ODD page 8 under Observation.

3. Press setup. The window should populate with the green elevation data, white and pink pipes, and blue and purple dots for houses (see below).

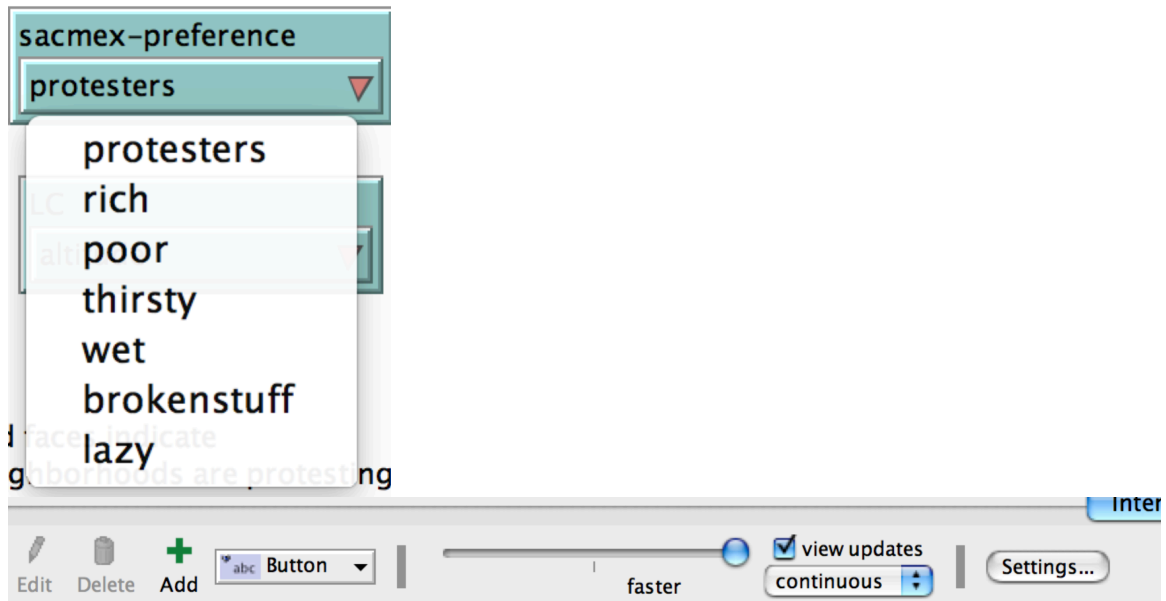


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Student handout

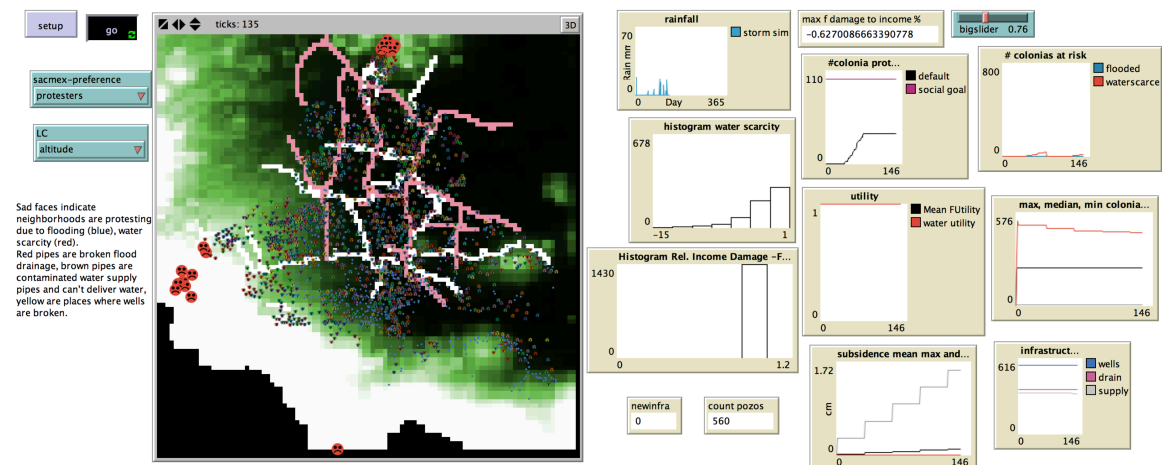


4. Select the governance scenario you have been assigned from the drop down menu of sacmex-preferences. Drag the slider that controls the speed – it is currently set to “normal” – drag the slide at the top of the screen to the far right so that it says “faster.” This will make the model run faster.



5. Press Go.

6. Notice how the plots populate, the colonias protest, and pipes and wells break and are built again. Run the model for 730 ticks. Ticks are identified in the upper left hand corner of the visual model window. While the model is running, discuss your governance scenario with your group or partner. Make some predictions. What effect (e.g. increase, decrease, no effect) do you think the governance model will have on the output variables listed in your worksheet as time goes on?

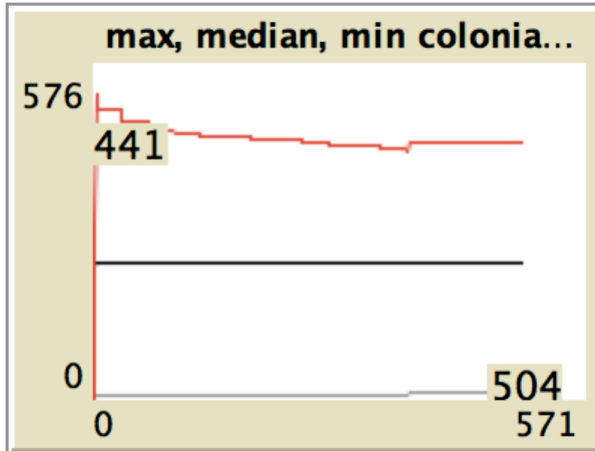


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7. After 730 ticks, press the “go” button to pause the model. Record observations in the worksheet table. To get numbers from plots, hover your mouse of the end point of the line (or maximum point of the line, depending on the question). You will see the value for the y value (which is the value you want to record) appear on the upper left corner of the graph near the y axis). The x-axis value is just the amount of time (# of ticks) the simulation has been run near the x-axis.



When done, Press “go” again, and run the model for 15 more minutes.

8. Read pages 7-16 of the white paper “Socio-Hydrological Risk Transfer and Emergent Vulnerability in the Basin of Mexico” that compares all 7 governance scenarios, and begin filling out questions in the worksheet (questions 1 and 3-5 can be completed while model is running).

9. After 10 minutes, or until the teacher says its time, press “go” to pause the model and record final observations. Finish answering question 2 and filling out the table.

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ABM WORKSHEET:

GOVERNANCE MODEL: _____

Initial thoughts/predictions for 3-5 variables (elect from table below) with your governance scenario- how do you think these will increase or decrease at 730 ticks? After 5000 ticks? (fill out predictions column, and provide some explanation here)

Table of Model Outputs:

Variable	Description	Predictions	After 730 ticks	After 5000 ticks or 15 mins
New infra:	count of new infrastructure built			
Pozos:	running count of wells			
Infrastructure:	running count of pipes and wells (report drains and supply only here)			
Median, max, min water:	shows daily water supply per household over time for colonias. (report all three)			
Subsidence:	tracks mean, max, and min subsidence over time (report all three)			
#colonias protesting:	cumulative number of neighborhoods in protest			
# at risk:	number of current colonias protesting for scarcity vs. flood risk. (report maximum number of both)			

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Questions to fill out for plenary discussion

1. Do you notice a relationship with the rainfall pattern and the season? How does this influence protest dynamics?
2. Were your predictions different from your outcomes? From the outcomes reported on graphs in pages 7-16 of the white paper?
3. Looking at table 3 in the white paper, which strategy would you choose if you were governing Mexico City as a “benevolent dictator”? As a politician trying to get elected? If you were trying to save money? If you just wanted to reduce water scarcity as much as possible? Why?
4. Which of the parts of system (according to your master models are well represented in the ABM (figure 1 of the ODD)? Which are over simplified?
5. Do you agree with the author’s conclusions on page 16/17 of the model analysis? Did the ABM answer the questions hypothesized on page 3? What hypotheses do you have about Mexico City you think an ABM could help answer? What data and new submodels might be required to answer that question?

Module 3

Final Summative Assessment: Homework

Policy brief

You represent a member of a new citizen's council to inform the city's course of action regarding water scarcity, flooding or both in Mexico City (you can pick what you want to focus on). You need to present your recommendation, supported by your knowledge of the social-ecological dynamics of Mexico City's water system. Your policy brief will have the following structure:

Statement of the Problem

What is the problem the action is addressing and why is this the most important issue to address? Why?

Recommended Intervention

Where, in relation to the interaction of system elements, do you propose would be the most effective point of intervention in the system? Why? What are the mechanisms (the programs, the type of activities or actions) that would make the intervention successful?

Responsibilities for Action

Who needs to be involved in implementing this intervention (who has power, who *should* have power and if they probably don't now have power, how can they be involved)?

Implications/ Consequences of Course of Action

What aspects of the system will be affected by this intervention (positive and negative) (refer to master model)? When will benefits be realized? When will any negative consequences be realized?

Use the readings over the entire course to support your course of action underpinned by relevant theory. Draw in at least 3 source not used in this class to make your case. You should also include and refer to your Master Model and, as appropriate, your stakeholder analysis. Use the ABM as empirical evidence for you claims, or identify other relevant data sources and describe the kinds of analysis necessary to support your claims.

The assignment should be succinct, but well researched and argued. It should be no more than 2000-3000 words, not including references.

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Rubric

Concept	Score (High potential)	...	Score (low potential)
Analyzing impacts of intervention on all system components and relevant actors	social and biophysical system impacts analyzed, relevant actors identified		missing major actors and system components, fails to specify potential impacts of specific vulnerability types
Understand influence, power and mental models	discuss current power/influence structure/mental models of actors necessary for action plan- and what needs to be changed to realize proposed plan		not a thorough analysis of how mental models of each actor limits or potentiates action plan
Use ABM or describe other data and methods to empirically underpin claims	clear graphs relevant to plan of action from ABM OR clear plan of how to analyze relevant data sets (cited) to generate needed evidence- can generate "mock" graphs if needed		lack of empirical evidence or clear plan as to how/what data to use to generate need information to test hypothesis
Make use of relevant theoretical frameworks	draws on concepts in all modules		draw on concepts in one module only
Include 3 additional sources	3 relevant sources used to compellingly support arguments		uses less than 3 sources, or sources are tangential to argument
Format	grammar, spelling, fluidity of writing		incorrect grammar, poorly structured or confusing writing, improper citations