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Environmental Change and Security Program

The World's Cities: Mapping Urban Growth in Developing Countries

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Edited Transcript— Karen Seto

Well, whereas Mark talked about people, I'm actually going to spend the bulk of my time talking about the land where people live. What I'd like to do today is talk about what we know and what we don't know, and really the post-colonic phrase of my title, "From Local to Global Patterns of Urban Land Use Change: What We Know and Don't Know," really should be, "And What Are the Implications of Not Knowing What We Should Know."

So Mark has just shot a bunch of holes into what I think we do know. So these are estimates of global population and projections under various scenarios. And you can see that there's a huge range, ranging from 7.8 to 11.9 billion people by 2050. And if we look at urban population by region, we see that there's quite a variation across regions. If we look at the the regions, let's say, of Latin America and North America, we see that as recently as 1990, more than 70 percent of the population of Latin America lived in urban areas. And in North America, very, very similar; something like 75 percent of people in North America live in urban areas. In contrast, if we look at Asia and Africa, only about 33 or 34 percent in both of those continents, and it's expected that these are the regions where urban population growth will be the greatest over the next 20 to 30 years.

So that's the people side. Where are these folks distributed worldwide? And this is where CIESIN has done a really significant amount of work mapping where urban settlements are. This is an example of the kinds of datasets that CIESIN's developed, and you can see that, not surprisingly, there are lots of settlements in India, eastern China, around the eastern seaboard. And if we look at these settlements in closer detail -- and, again, these are datasets produced by CIESIN -- we can see where they are located in terms of ecosystems. So we can see where settlements are vis-a-vis cultivated lands and coastal zones, et cetera. And if we want to zoom in further to the sub-global level, to national levels, we see that, again, CIESIN has produced a number of maps, datasets of population density across the world.



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But what these maps don't show are the variations in these estimates in terms of the size and even the locations of where urban settlements are. And this is a graph taken by a study done by David Porter and Annemarie Schneider where they compared estimates of urban settlements using a variety of different datasets. And the take-home message here is, whether you use GRUMP, or whether you use some of NASA's assets from MODIS, or whether you use LandScan dataset or the Nighttime Lights dataset, you get very different estimates of the spatial extent and certainly the spatial pattern of urbanization. So there is one of the things that we don't know. We think that we know, but we don't know the spatial configuration of urban areas, basic information, I think.

The other thing that we don't know is we know very little about land use change. So Mark's talked about city growth and urban growth really as a demographic process. I'm thinking about urban growth as a land change process. And what are the ecosystems at risk? Where are the farmlands most likely to be converted, the biodiversity hotspots that are closest to urban areas? So there's very little understanding about global rates of urban land use change. And one of the things that's, I think, particularly surprising for me, is we actually have very little understanding about how urban areas have changed historically, despite more than 30 years of satellite data. So we don't really know how urban areas have developed. Are they growing more expansively? The term "urban sprawl" always gives me the heebie-jeebies, because I don't really know what that means, but it's used extensively. So we don't know how urban areas are growing. We don't know where they're growing. Are they becoming more compact in nature? And if we don't understand the past, someone very clever once said, we're very likely to repeat it in the future.

This is a graph taken from Mark's paper in *Science* last year, which shows that most of the growth in the coming decades is actually going to occur in small and medium-sized cities. And so here's another point that I want to leave with you this afternoon is we actually know very little about small and medium-sized cities. We know quite a bit about the Shanghais, the Mexico Cities, the New York Cities of the world, but these smaller towns and smaller cities where a majority of the growth will take place in the coming decades are regions that are not being monitored very consistently.

So my group, previously at Stanford and now at Yale, has done local-scale studies across the world, but primarily in Asia. And I just want to highlight a couple of case studies that we've done. And one of the things that we've taken away from these local-based case studies is that, despite very different national and local policies, economic policies, very different





demographic patterns, there are some common themes that are emerging in these growing regions.

This is a picture taken from south China, provided by the Shenzhen Planning Bureau. This is a region just north of Hong Kong. This is a picture taken in the early 1970s, and it's a region that primarily was agricultural, [which] very much could be described as a town. And this is a picture taken just a few years ago. It is literally a region that has gone from a fishing community to one of the largest manufacturing hubs in China. And these are the images or the physical manifestation of urban population growth.

So this is one of my favorite pictures, that I took in the mid-90s there, something that's straight out of Southern California, but now being transplanted not only in south China, but really we're seeing this style of low-density, single-family homes all around Asia where we're working. And then we're also seeing these McMansion-style developments that are quite impressive, I think would be quite impressive to most North Americans.

So what do these patterns of urban land use change look like? I'm going to show a series of animations from our case studies. I'm going to start off in south China in the Pearl River delta. The pictures that I just showed you were taken here in Shenzhen. This is of the southern province of Guangdong. And this is a Landsat image taken in 1999. And we've been monitoring this area using data starting in 1973. And what you see in purple are the urban areas in 1973. And as we move through the animation through time, you can see that the area has grown significantly in terms of urban land change, and most of the land that's been converted to urban areas are primarily farmland, which is not surprising.

So we'd been working in the Pearl River delta and the coast of China, and the rates are quite astronomical. And we thought, "Well, maybe this is just an anomaly in south China, on the coast, since a lot of the Chinese policies have been directed to the coast." So we conducted a study in Chengdu, in the Szechuan Province of China, and we found, actually, very similar patterns and rates of growth there as well. And one of the very interesting things here is that the remote sensing analysis shows that most of the growth occurs here in the west and in the south, but actually most of the policies were directed at growth in the north and in the east.

So we actually have very little understanding of the drivers of the spatial configuration of urban growth. So the two examples I showed are from China, and I just want to highlight





that these patterns of urbanization land change are occurring not only in China but also in other parts of the world.

And this is some work that we've done in Qatar. And this is Doha in 1973, and some satellite cities in 1973. And very similar to cities in China, we're seeing quite a bit of expansive and extensive development over a 20-year period. And this is not limited to Asia. And, in fact, a lot of studies around the world, even in North America, have shown similar patterns.

Again, this is work that we've done here in Silicon Valley, and most of the development in Silicon Valley also took place in prime agricultural lands. So that's one of the main themes that I want to leave you all with, is how and where urban areas have and will develop will affect every aspect of our lives in the coming decades. And I recognize that probably most everyone here is not interested in urban issues and urban areas the way Mark and I can talk about urbanization for a long time. But be it biodiversity or food production or climate change or energy consumption, whether cities grow in a compact fashion or expansive, whether urban areas grow in water-constrained areas or whether they're in coastal zones or whether cities really grow up... And, again, another picture of Shenzhen. And this is a picture taken from *National Geographic*, which is of a region north of Beijing. Whether cities grow up or out will have significant impacts on earth system functioning, and, again, every aspect of life, not just in the countries where urbanization is happening, but really worldwide.

So, from our various studies around the world, one of the things that we have found is that there's very little understanding of global patterns of urban land use change. Our understanding of what's happening tends to be limited to individual case studies similar to the ones I just showed you for Doha and for Shenzhen. And we have very little understanding of the global trends, the global patterns. So, for example, we don't have an estimate of global or regional rates of urban land change. We don't know whether the most productive agricultural lands are being lost to urbanization. If we try to forecast energy demand, we have to know something about whether cities are being developed so that people need to rely on transportation systems or private vehicles, and we don't have that basic kind of spatial configuration about cities.

So, in response to this lack of information, my group and the IHDP project on urbanization and global environmental change, for the last couple of years, we've been conducting this





meta-study of peer reviewed studies on urban land use change. And I'm going to show just a couple of the highlight results here. And one of the surprising things for me is that of all the peer-reviewed studies that have been published, there have been only 291 cities or urban regions that have been monitored in terms of looking at land change. So we've looked at 335 case studies, but, of those 335 peer-reviewed studies, only 291 cities are actually covered. If we look at the breakdown of the areas that are being studied, we see that a lot of the studies are in China. There are a number of studies in North America. But if we go to Africa, India, Southeast Asia, and the rest of East Asia, there are very few studies about urban land use change.

If we look at the cities that have grown over the last 20 years – in these charts adapted from the UN-- in 1980 Tokyo was the largest city, and Tokyo's gone down in rank. Or New York has gone down in rank. Now York is now somewhere down here. If we look at the cities and how they've changed in size in terms of population and we compare it to what we know in terms of land change, we see that not all the cities are actually covered by the meta-analysis. And so that's another surprise: that you would envision that the cities that were the biggest in 1980 would have been monitored with remote sensing or some kind of empirics, like remote sensing. So, one of the key points is that we are not monitoring spatially very rapidly growing urban agglomerations.

I'm just going to skip over this slide and show you some other results from the analysis. These are average annual rates of growth during the study period. And really the study period starts in 1972 through 2000, and these are annual rates for the entire period. And, on the bottom, these are increases in urban areas during that same period. The point that I want folks to take from this slide here is these are just estimates of urban land change from the peer reviewed studies, which shows that a lot more urban areas were developed in North America than in China during this 30-year period.

And, again, if you just aggregate the total numbers, the total area of urban land change over this about 30-year period, we see that there's about an area of 58,000 square kilometers that have been converted from farmland or other ecosystems to urban areas, which is roughly twice the size of Maryland or twice the size of Belgium.

If we start looking at annual average rates of change per decade, we see that there's a lot of variation in East Africa or East Asia and in China, but there's actually very little variation in the rates of change in North America. So this is telling us that cities in North America, in





terms of their footprint, are growing at about the same rate annually during these decades, less than five percent, and that the range of growth is not very great. And, in contrast, if we look at China or East Asia, here in China we see that there's a very large variation. In Central and South America there's a very large variation. And that basically is a reflection of differences in policies between coastal and non-coastal areas, bigger cities and smaller cities.

And if we compare these average annual rates of change of land change to urban population change, this is what I think is one of the most interesting results from the study, and we've been running models to quantify this. And basically what the results show is that across the board for many regions of the world urban land change is happening at a faster rate than population change. So, in terms of the amount of land required to support the urban population in the decades to come, we're increasingly going to need more and more land, or more land will increasingly be converted to urban uses.

So what are the implications of not knowing? So what? We haven't known for a long time, and just because we have these NASA assets, you know, what's the big deal? I would argue a couple of things. One is that we're not able to evaluate the effectiveness of policies, whether it's urban policy or whether it's some type of economic policy to derive or direct land development. Another increasing [concern] -- really a big issue, I think, at the global scale -- is land conservation efforts. And if we're interested in saving the most biologically productive areas or biological hotspots, we need to think increasingly at the global scale, and look at areas that are growing in terms of urban expansion.

I think, in today's climate and especially following on Mark's discussion about urbanization and climate change, in terms of energy consumption and greenhouse emissions, the spatial configurations of these cities and the two billion urban dwellers that are going to be added to the earth in the next 30 years will have a huge impact on energy consumption. And I know that I've probably made a number of enemies by saying we're not going to solve the energy crisis by giving everyone a hybrid car, and we're not going to solve the energy crisis by having green buildings. I think green buildings are part of the solution; hybrid cars are part of the solution, but if we develop cities so that people are zoned to live here but they're zoned to work here and the two should never meet other than by a road and a hybrid car, we're certainly going to dig ourselves in a bigger mess. And so, in many ways, I would argue that the energy policies and climate policies really need to take into consideration urban policies and how cities are developing.





Mark mentioned this a little bit: adaptation to climate change, and I would like to just touch on this point of co-benefits and really triple-benefits of thinking about how cities can be re-imagined or developed in the decades to come. And how they are developed can both help mitigate climate change but also help provide more or direct more effective policies for adaptation. So, currently, a lot of the policies at local levels are, “We need to develop very quickly. We need to develop our urban infrastructure. We need to bring Microsoft into develop our city economy. And then once we are developed, we’ll think about climate change afterwards.” And there really is an enormous opportunity, and, really, I would argue, this is low-hanging fruit in terms of thinking about how cities can develop in the future.

One of my big issues is agricultural land, and, you know, we’ve been doing studies in China that show that most of the land that’s being converted to urban uses is prime agricultural land. And many case studies around the world are showing this. But we don’t have a global snapshot of the most productive agricultural lands. And even if we were to, say, “Urban areas only take about three to five percent of the earth terrestrial surface,” the question is how many, or what are the increases in energy, water, and fertilizers required to increase yields in more marginal lands? So there clearly is a tradeoff between how we develop our cities and agricultural production.

And there is a growing literature, beyond the literature on urban heat island effect, which is showing that urban growth and the pattern of urban growth has effects on not only the temperature of local areas but certainly precipitation at local and at regional scales.

So not knowing how urban areas are changing and how they’ve changed in the past has huge implications across a number of different fronts.

So, a couple of final points: One point is a plea to federal agencies out there that, despite more than 30 years of satellite observations, our understanding about urban land change is relatively small, and it’s fragmented. We know about urban land change through individual case studies, but we need much more concerted studies and efforts to understand at a global scale what’s happening across regions. And we need to have many more studies for smaller and medium-sized cities.

For many regions around the world, urban land change is faster than urban population change. So, again, if we think about the estimated two billion new urban dwellers over the next 20-30 years, the rate of growth of urban populations is going to be smaller than the land





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required to support them. And so where these lands will come from, whether they're in arid areas or coastal zones, will have implications for all the issues that I touched upon previously: energy use, greenhouse gasses, adaptation, et cetera.



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