The Urban Genome Project: Deciphering Cities’ DNA to solve sustainability challenges

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Outline of this evening’s talk

1) Personal and institutional background
2) Global sustainability challenges and city-scale solutions
3) Urban sustainability experiments by different sectors
4) How do we shape the future of a “green Phoenix”?
5) Rationale for an Urban Genome Project
Main takeaway messages

1) Cities are the ideal scale for achieving global sustainability
2) There is an explosion of urban sustainability work going on now
3) Cities need coordination like that of the *Human Genome Project*
4) Metro Phoenix can be one of the world’s leading Sustainable Cities
Personal Background

- Volcanology professor at ASU
- Department Chair, VP Research, Sustainability Director
- Helped promote interdisciplinary culture at ASU
- Heavily involved in regional economic development
- New Center focuses on cross-sector sustainability research
Institutional Background - ASU

- One of largest universities in U.S. (~ 67,000 students)
- Four campuses in Metro Phoenix under one administration
- Interdisciplinary, global, socially relevant, use-inspired
- Sustainability has been a top institutional priority since 2002
ASU’s Global Institute of Sustainability

- First degree-granting School of Sustainability (BS, MS, PhD)
- University practices that reflect principles of sustainability
- University-wide Sustainability Research Federation
- Decision Theater links research to community’s policy needs
School of Sustainability

- Global urbanization
- Energy and materials
- Water quantity and quality
- Biodiversity
- Values and ethics
- Business practices
ASU Sustainable Business Practices

- Solid waste
- Transportation
- Energy
- Buildings
- Food
- Purchasing
- Water conservation
- Public education
The Earth’s Climate is Changing

- Polar melting, 1979-2005
- Worst bush fires, 2010
- European heat wave, 2003
- Hurricane season, 2005
Are the changes all “natural”?

Take out:
- El Nino
- Volcanoes
- Solar cycles

Left with:
- CO2 emissions

J. J. McCarthy Science 326, 1646-1655 (2009)
There are ways to stabilize the climate, but they require immediate action.

*J. J. McCarthy Science 326, 1646-1655 (2009), after Socolow and Pacala*
The 15 Climate Carbon “Wedges”

1. More efficient vehicles
2. Reduced use of vehicles
3. More efficient buildings
4. More efficient coal plants
5. Swap gas-based power for coal
6. Capture CO2 at power plants
7. Capture CO2 at H2 plants
8. Capture CO2 at coal-to-synfuels plants
9. Swap nuclear power for coal power
10. Swap wind power for coal power
11. Swap PV power for coal power
12. Swap wind-based H2 for gas in hybrids
13. Swap biomass fuel for fossil fuel
14. Reduce deforestation
15. Use conservation tillage
Whether or not one “believes” in global climate change, the path we are on is unsustainable.

If everyone in the world lived like an average North American, we would need five planets to live on.
How to best respond to the need for change?

*Countries* sign global treaties
But binding agreements, if any, are watered down

*Companies* find ways to profit from change
But if profits and public good conflict, profit wins

*Individuals* can change their behavior
But unless everyone does it, most put it off

*Cities* and regions try lots of different approaches
But each one tends to do its own thing

*Each city can be considered an experiment*
Cities are ideal scale to address sustainability

- More than half the world’s population is now urban
- Cities are best scale to balance consumption and resources
- Urban density leads to reduced energy and water consumption
- Population within a city easier to communicate with
- People more responsive to local politics
Large cities have lower energy use per capita.
Large cities have lower per capita CO2 emissions

![Bar chart showing CO2 emissions per capita by city population size]

- Cities with less than 500,000 people have an average CO2 emissions per capita of 6.74.
- Cities with 500,000 to 999,999 people have an average CO2 emissions per capita of 4.73.
- Cities with 1,000,000 to 1,499,999 people have an average CO2 emissions per capita of 5.03.
- Cities with more than 1,500,000 people have an average CO2 emissions per capita of 3.77.
Transportation emissions scale with population density

How can we greatly improve these efficiencies?
Massive urbanization in China and elsewhere provide huge opportunities for large impacts.

400M Chinese moving to cities from rural areas
Four sectors help conduct urban experiments

**Government**
- Fund
- Protect
- Regulate
- Negotiate

**Universities**
- Educate
- Discover
- Convene
- Integrate

**NGOs**
- Advocate
- Defend
- Inform
- Solicit

**Corporations**
- Contribute
- Innovate
- Employ
- Invest
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How can Federal urban systems research be better coordinated?
How can Federal urban systems research be better coordinated?
Federal approach to urban systems is fragmented

Federal Mission Agencies

- HUD
- NIEHS
- CDC
- EPA
- USGS
- NOAA
- NASA
- USFS
- USDA
- BLM
- DOT
- DOL
- DOJ
- DHS
- DOD
- DOE

- HEALTH
- WATER
- AIR
- CLIMATE
- FORESTS
- AGRICULTURE
- LAND USE
- TRANSPORTATION
-UFACTURING
- URBAN SECURITY
- ENERGY
How can the study of urban systems be coordinated?

Federal Mission Agencies
- NIEHS
- DOE
- EPA
- NASA
- NOAA
- USGS
- USFS
- DOC
- DOD
- HUD
- ADHS
- APS
- SRP
- AERO
- ADWR
- ADEQ
- SFAz
- ADOA
- ADOC
- MAG
- ADOT
- USDA
- BLM
- MAG
- ADOA
- ADOC
- GPEC
- APS
- DOJ
- DHS
- DOC
- DOL
- DOT
- ADHS
- ADOA
- ADOC
- GPEC
- APS
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- ADOC
- GPEC
- APS
- DOJ
- DHS
- DOC
- DOL
- DOT

State and local agencies have the same problem
ASU used one project to connect pieces for Phoenix.
How can the study of urban systems be coordinated?
Do urban transport and land use affect water?
How do energy efficiency and climate interact?
First joint Federal urban research program in 2009

HUD-DOT-EPA Initiative for Sustainable Communities
ASU’s Urban Systems Research Focus

- CAP-LTER, one of two Urban LTERs
- Two Urban Ecology IGERTs (NSF)
- Agrarian-urban transitions (NSF)
- Heat Island Research Center (EPA)
- Urban Fluid Dynamics (ADEQ, EPA)
- 100 Cities remote sensing (NASA)
- Decision Center for a Desert City (NSF)
- Morrison Institute for Public Policy
- Center for Science, Policy & Outcomes
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Central Arizona – Phoenix Long Term Ecological Research

One of only two urban LTERs

young city
rapid growth
arid climate
rugged topography

old city
slower growth
humid climate
flat terrain

Phoenix

Baltimore
How does urbanization affect city’s underlying ecosystem?
How does regional ecosystem constrain urban development?
How does air pollution affect ground water, soil?
Urban Heat Island Effect

Night time temperatures go up a lot in city
How to reduce Sky Harbor’s thermal footprint?

*Urban heat island has health, water, and energy consequences*
New materials can reduce Sky Harbor’s impact

Low Albedo
High Thermal Mass

High Albedo
High Thermal Mass

Anthropogenic Heat

Low Albedo
High Thermal Mass

High Albedo
Low Thermal Mass

Low Albedo
Low Thermal Mass

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ASU-NASA 100 Cities Remote Sensing Project
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100 Cities partner cities

Partners
- Existing
- Negotiating
- Planned
100 Cities Project:

- Annual day and night images collected for each city
- Goal is to partner with local groups in all 100 cities
- Can we develop a taxonomy of growing cities?
- How can cities minimize their environmental impact?
- Collaborating with World Bank
Ultimate goal: “City Sat” remote sensing satellite

- Urban remote sensing data difficult to obtain
- Often can’t access satellite data of cities
- Existing instruments not optimized for cities
- Solution is a dedicated urban satellite system
- ASU and NASA now planning “CitySat”
Decision Center for a Desert City

- Addresses urban water decision-making under uncertainty
- Regional stakeholders engaged from start to finish
- Decision Theater helps them assess alternative futures
- Could also apply to air pollution, energy, traffic, food
“WaterSim” forecasting tool in Decision Theater

*WaterSim has* many user-adjustable variables
Watershed Simulation  Climate Change  Land Use & Population  Policy Tradeoffs  Groundwater Sustainability

More technical ← Slider bars on graphs allow alternate futures to be assessed in real time → Less Technical

WaterSim also available online at http://watersim.asu.edu
Policy Tradeoffs

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Policy start year: 2020
Total estimated gallons used per person per day under policy: 224

Indoors: 78
- toilet: 1.2 gallons/day
- clothes washing: 1 gallon/load
- showers: 3 gallons/bath
- baths: 3 gallons/bath
- faucet: 0.7 gallons/min
- leaks: 2 times/year
- other domestic: 1.5 gallons/day
- dish washing: 0.1 gallons/load

Outdoors: 146
- Density of urban expansion
- Non-desert landscaping: 13%
- Pools: 13%

Decision Center for a Desert City
Groundwater Sustainability

Scenario summary:
Colorado: 1970-1994 historical period; 100% of average 2006-2030; 100% of historical runoff
Salt/Verde: 1970-1994 historical period; 100% of average 2006-2030; 100% of historical runoff
Population: 100% of DES
Agriculture: buildout by 2069
Policy: starting in 2020; indoors usage of 78 gpcd; outdoors usage of 146 gpcd
MIT Senseable Cities Lab “Copenhagen Wheel”

“Transform your ordinary bicycle into a hybrid E-BIKE that also provides feedback on pollution, traffic congestion and road conditions in real-t
World Bank’s Global City Indicators Facility

Announcements

New Cities
- Ile de France Joins
- Isulan Joins
- Dhaka Joins

New Developments

Upcoming Events
- United Nations - World Urban Forum 2010
- GCIF is hosting an event with member cities and the launch of its annual report at UN Habitat’s World Urban Forum in Brazil 2010.
- Dubai Workshop Winter 2009/2010
  GCIF will co-host a workshop with the Center for Research and Urban Innovation on the
Cisco Systems’ Connected Urban Development

Introduction to Connected Urban Development

Connected Urban Development (CUD) demonstrates how to reduce carbon emissions by introducing fundamental improvements in the efficiency of the urban infrastructure through information and communications technology (ICT). Connected Urban Development was born from Cisco's commitment to the Clinton Global Initiative to participate in helping reduce carbon emissions. The founding CUD cities are San Francisco, Amsterdam, and Seoul. In 2008 four new cities have joined the program - Birmingham, Hamburg, Lisbon, and Madrid - beginning a new phase for CUD and opening new avenues for collaboration in promoting smart urban environments globally.

EcoMap Connects Urban Development

The EcoMap is a tool that connects urban development with environmental sustainability. It shows how cities can leverage technology to reduce their carbon footprints and create more livable, sustainable environments.

Connected and Sustainable Energy Solutions

- Urban Energy Management
- Smart Urban Energy for Schools

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CUD’s Urban EcoMap for Amsterdam, San Francisco and Seoul

Urban EcoMap
Working Together to Improve Urban Environments

Urban EcoMap is an interactive decision space that empowers individual citizens to make informed decisions about their daily lives, along with how to participate in the vitality of their communities. We aim to build awareness, fostering a sense of community, and provide actions for citizens to take to enable the reduction of greenhouse gas emissions in cities. Please join us.

Amsterdam
Population: 746,935
Residential CO2 Emissions:
- Transportation: 45.1%
- Energy: 50.9%
- Waste: 4.9%

San Francisco
Population: 762,611
Residential CO2 Emissions:
- Transportation: 78.1%
- Energy: 19.4%
- Waste: 2.5%

Together we can strive to achieve a reduction in carbon emissions to 2 metric tonnes(1) per capita.

Learn More
EcoMap shows environmental impact by zip code
EcoMap shows individuals how to reduce their footprint
IBM’s Smarter Cities Program

Combining new sensor technologies with computer models for better management decisions
Non-IT companies can be partners for urban sustainability research

- Wal-Mart: (retail supply chain)
- Waste Management Inc: (material flows)
- CEMEX: (construction materials)
- Veolia: (urban environmental monitoring)
- BP Solar: (urban renewable energy)
- U Haul: (social mobility)
- Henkel/Dial: (home products)
- Arizona Public Service: (electricity generation)
- Salt River Project: (urban water and power delivery)
What can we learn from other cities?

• Cities taking the lead in discovering sustainable solutions
• Each city has unique challenges and opportunities
• Competition to be “green” is helping cities find new ideas
• Regional cooperation is essential
Chicago

- Urban Heat Island mitigation policies include incentives for cool roofs, pavements, and urban forestry
  - Planted 500,000 new trees
  - 2 million square feet of green roofs (more than rest of US)

Green and cool alley way project

Green roofs 70 degrees cooler
Vancouver, B.C.

- Neighborhood Energy Utility: Space heating and hot water use heat recovered from sewers and from solar collectors
- Climate Change Action Plan: All new construction in Vancouver will be GHG neutral by 2030
Curitaba, Brazil

- All-bus rapid transit system: inexpensive “social fare” leads to Brazil’s highest ridership, lowest per capita pollution
- Green Exchange employment program lets low income families trade their trash for bus tickets and food
Sustainable Cities in Arizona

- Scottsdale: Green Building Program
- Tempe: The Carl Hayden Campus for Sustainability
- Flagstaff: Municipal sustainability inventory
- Tucson: Full implementation of Agenda 21
Sustainable Phoenix

• Riparian area restoration and preservation
• Pollution prevention and recycling
• Tire recycling: rubberized asphalt
• Transit park-and-ride solar shade structures
What can “tan” cities say to “green” cities about sustainability?
What can “tan” cities say to “green” cities about sustainability?

Green City View of Tan People
Tan City View of Green People
Phoenix is dealing with problems today that other global cities will face in the future

- Water shortages due to consumptive lifestyles and low prices
- Heat island effect caused by hot climate and built environment
- Immigrants fleeing poverty and environmental degradation
- Auto-based economy vulnerable to high fuel costs
- Current lack of renewable energy generation
- Food, fuel, and water supplies transported long distances
- Epidemic of childhood asthma related to poor air quality
Sustainable Cities Network helps cities learn from each other
ASU contributions to “greening” of Phoenix

- ASU helped prepare $75M “Green Phoenix” US DOE proposal
- Sustainable City Network involves managers from all cities
- ASU helps recruit greentech companies like Suntech
- Customized research for urban sustainability solutions
  - **Renewable energy: Solar and algae-based biofuels**
  - **Energy efficiency: Building and neighborhood redesigns**
  - **Heat island effect mitigation: New materials and strategies**
Do We Need an Urban Genome Project?

- Human Genome Project sought to cure human diseases
- Urban Genome Project seeks to cure planetary diseases
- Each person has unique characteristics embedded in DNA
- Each city’s unique characteristics are reflected in its “DNA”
- HGP required multiagency and private sector funding
- Urban Genome Project needs multi-sector support
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Center for Sustainability Science Applications: http://cssa.asu.edu
Global Institute of Sustainability: http://sustainability.asu.edu
School of Sustainability: http://schoolofsustainability.asu.edu
Decision Theater: http://dt.asu.edu
Central Arizona-Phoenix Long Term Ecological Research: http://caplter.asu.edu
ASU Heat Island Research: http://asusmart.com
100 Cities program: http://100cities.asu.edu
Decision Center for a Desert City: http://dcdc.asu.edu
WaterSim: http://watersim.asu.edu
Sustainable Cities Network: http://sustainablecities.asu.edu
MIT Senseable Cities Laboratory: http://senseable.mit.edu
Copenhagen Wheel Video: http://www.youtube.com/watch?v=U5k25-hHNrc
Cisco Connected Urban Development: http://www.connectedurbandevelopment.org
Urban EcoMap: http://www.urbanecomap.org
IBM Smarter Cities: http://www.ibm.com/smartercities
World Bank’s Global City Indicator Facility: http://www.cityindicator.org
One Planet Living: http://www.oneplanetliving.org