Why have an urban system science research agenda?

- More than half of the world’s population now lives in cities
- Global urban infrastructure must be duplicated in next 35 years
- Little scientific input today on how to make cities sustainable
- Global climate change is driven increasingly by urban activities
- Cities have growing impact on surrounding undeveloped lands
- Decision-making processes are not understood scientifically
Rapid urbanization in China and USA

- Urban growth rates across China are unprecedented
- Fastest urbanization in US is in South & West ("Sunbelt")
- Urban migrants seek jobs and improved quality of life
- Urbanization causes political and environmental stress
- Issues include clean water, clean air, traffic, land use, service access, security concerns, decision-making
Why is Phoenix a good place to study?

- 5th largest, 2nd fastest-growing city in USA
- Geography, climate, hydrology, history relatively easy to model
- Several large federally-funded environmental research projects
- Strong collaborations of state agencies, industry, universities
- *Greater Phoenix 2100* program making Phoenix a wired, modeled, natural laboratory for study of rapid urbanization
How can study of US urban systems be coordinated?
How can study of US urban systems be coordinated?

Who is in charge?

誰負責？誰操作？
How can the study of urban systems be coordinated?
How can the study of urban systems be coordinated?
How can the study of urban systems be coordinated?
How can the study of urban systems be coordinated?
What can an urban research lab do?

• Automated collection of air, water, land cover, biologic, social, traffic data
• Link new and existing data streams
• Put all data in common formats
• Use a variety of models for forecasting
• Translate the results for policy makers
• Expand global relevance through collaborations with other cities
ASU’s urban research assets (1)

- One of two Urban LTERs (NSF)
  - Tracks impacts of humans on the Phoenix ecosystem, and vice versa

- Urban Ecology IGERT (NSF)
  - Trains next generation of ecologists

- Agrarian-urban Biocomplexity (NSF)
  - Studies conversion of farmland to cities

- Decision Center for a Desert City (NSF)
  - Studies how water use decisions are made

- 100 Cities Project (NASA)
  - Integrates urban remote sensing applications
  - Uses ASU/JPL Mars Space Flight Facility
  - UrbanSat plan for 1 or 2 new satellites
100 Cities Project: Standardized, repeated urban remote sensing

Partners

- Existing
- Negotiating
- Planned
Different sensors = different information

Las Vegas, NV, 17-Oct-2000

Visible to near-infrared
15 m/pixel
- Major land cover classes
- Vegetation health
- Soil properties
- Soil contamination

Shortwave infrared
30 m/pixel
- Urban surface materials
- Rooftop materials
- Energy use
- Fugitive dust production
- Metal contamination
- Ecological communities

Thermal infrared
90 m/pixel
- Surface energy balances
- Regional climate models
- Anthropogenic heat sources
- Heat island development

不同遥感探测器获取不同信息
（以拉斯维加斯大赌城为例）
100 Cities Project:

- Annual day and night images collected for each
- 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?
- What do cities contribute to global atmosphere?
- How can technologies promote sustainability?
ASU’s urban research assets (2)

ASU 还在城市空气动力学，城市政策，城市规划和城市生态学诸方面多有研究

• **Urban Fluid Dynamics**
  – Measures/models urban air flows
  – Works with State Dept. of Env. Quality
  – Links to public health studies

• **Morrison Institute for Public Policy**
  – Influential think-tank directs policy applications

• **Consortium for the Study of Rapidly Urbanizing Regions**
  – Links rapid urbanization studies around the world

• **Greater Phoenix 2100**
  – Translates science for policy makers
  – Defines 100-year and regional views for metro Phoenix
  – Combines numerical models for air, water, land-use
Greater Phoenix 2100 - Goals

• Develop visualization tools to help policy-makers better understand implications of their decisions

• Make science and engineering results more accessible

• Promote regional and long-term perspectives

• Partner with businesses and state agencies
Greater Phoenix 2100

Visualization tools

- Regional e-Atlas
- SIM Phoenix
- Decision Theater
- Urban-SAT(s)
Atlas addresses diverse topical issues

**Table 2: Scenarios For Future Growth of Greater Phoenix**

<table>
<thead>
<tr>
<th>Year</th>
<th>SCENARIO 1: ANNUALIZED GROWTH RATE OVER THE LAST 50 YEARS (4.4%)</th>
<th>SCENARIO 2: LOWEST ANNUALIZED GROWTH RATE OF ANY SINGLE DECADE OF THE LAST 50 YEARS (3.4%)</th>
<th>SCENARIO 3: LOWEST ANNUALIZED GROWTH RATE OF ANY SINGLE DECADE OF THE LAST 100 YEARS (2.2%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>3,251,876</td>
<td>1,207</td>
<td>3,251,876</td>
</tr>
<tr>
<td>2010</td>
<td>5,009,144</td>
<td>1,859</td>
<td>4,549,622</td>
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<td>2020</td>
<td>7,716,016</td>
<td>2,864</td>
<td>6,365,269</td>
</tr>
<tr>
<td>2030</td>
<td>11,885,644</td>
<td>4,411</td>
<td>8,905,496</td>
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<tr>
<td>2040</td>
<td>18,308,480</td>
<td>6,795</td>
<td>12,459,468</td>
</tr>
<tr>
<td>2050</td>
<td>28,202,126</td>
<td>10,467</td>
<td>17,431,745</td>
</tr>
</tbody>
</table>

How fast will Metro Phoenix grow?
Water: Supply, Use and Quality
Change in water well use 1985-2000

1985-2000水井利用变化情况

Critical limit on future population size
Maps deal with politically-charged issues

如何保护最理想的自然环境区？

How to preserve most desirable areas?
Atlas shows extent of Urban Heat Island

Another possible limit on urban growth
Greater Phoenix 2100

Visualization tools

- Regional e-Atlas
- SIM Phoenix
- Decision Theater
- Urban-SAT(s)
Greater Phoenix 2100

Visualization tools

• Regional e-Atlas
• SIM Phoenix
• Decision Theater
• Urban-SAT(s)

Model the future of the region
Greater Phoenix 2100

Visualization tools

- Regional e-Atlas
- SIM Phoenix
- Decision Theater
- Urban-SAT(s)
Greater Phoenix 2100

Visualization tools

• Regional e-Atlas
• SIM Phoenix
• Decision Theater
• Urban-SAT(s)

A place to convene decision-makers
Visualization tools

- Regional e-Atlas
- SIM Phoenix
- Decision Theater
- Urban-SAT(s)
Greater Phoenix 2100

Visualization tools

• Regional e-Atlas
• SIM Phoenix
• Decision Theater
• Urban-SAT(s)

Instruments customized for urban monitoring
ASU-China Urban Research Collaborations

• Urban air pollution measurement and modeling
• Visualization of surface water and ground water resources
• Remotely sensed monitoring of land use changes
• Correlate public health and environmental conditions
• Compare decision-making processes in China and US