# Analysis of Phoenix, AZ Heat as a Social Ecological System

December 4, 2015

# 1 Part I: Static Analysis - Collective action

Phoenix, AZ is the 6th largest city in the United States with a population of 1.5 million in 2014, and is over 500 square miles large. It is also one of the hottest cities in the country with an annual mean temperature of 75ºF, and a summer average of 93ºF.

Cities have a finite capacity to dissipate heat into the environment; this is a resource that Phoenix residents use within an urban heat resource system. This resource can be amplified or attenuated by human-made public and private infrastructure, which can include, public green spaces and building codes, or private net-heat-generating air conditioning and automobiles.

## 1.1 The Commons Dilemma

The common pool resource dilemma in the Phoenix case is the potential for under investment in public infrastructure and over appropriation of the resource. The institutions in the Phoenix case study create a public goods style social dilemma, whereby no individual will pay enough for the non-excludable and asymmetrical benefits of public cooling infrastructure, particularly in light of complex feedback systems and trade-offs, leading to private cooling behaviors at the expense of optimal aggregate cooling capacity.

In the phoenix case the over appropriation of the resource has not been overcome, although the under provision of public infrastructure designed to conserve the resource has been partially overcome. Public intervention via soft human infrastructure in the form of zoning has helped relieve some of the stress on the resource.

## 1.2 Biophysical Context (IAD)

### Natural infrastructure (NI):

The natural infrastructure involved in the Phoenix case study consists primarily of natural mesic, oasic, and xeric topography in the form of grass, trees, shrubs, succulents, cacti or dirt. These different forms of natural infrastructure have large effects on the primary resource system, either increasing or decreasing the availability of the primary resource.

Additionally, climate and weather play an integral role in this resource system, with extreme summer het causing the largest problems. Unfortunately, climate change is guaranteed to cause the resource to be become scarcer.

### Hard human-made infrastructure:

Large multistory glass buildings, medium masonry buildings, concrete and asphalt roads and walkways, single story residential buildings, as well as various roofing materials in the

form of wood, tar, tile, or reflective materials, and parks and recreation areas make up the passive hard human made infrastructure. Additionally, automobiles, factories, trains, and airplanes make up some of the active hard human made infrastructure in the resource system. The passive hard human made infrastructure affects the background availability of the resource and mediates its relationship with natural climate and weather cycles, while the active hard human made infrastructure mediates the resource by directly using or not using it.

## 1.3 Attributes of the Community (IAD)

### Social Infrastructure

The social infrastructure involved in this system consists primarily transportation and recreation patters between individuals in the system whose lifestyles mediate the availability of the primary resource. Long commutes to work, and driving throughout the city in personal automobiles contribute significantly to the over appropriation of the resource.

### Human Infrastructure

Human infrastructure in the form of decision making about the use of the primary resource does mediate its availability. Knowledge about cooling via landscaping and attempts to reduce use of unnecessary automobile travel or air condition can help conserve the resource.

## 1.4 Rules in Use (IAD)

In the case of urban heat dissipation capacity in Phoenix, AZ, soft human-made infrastructure is the most flexible and best suited to fixing the over appropriation problem. Without regulation through soft human made policies and laws, continued development of hard human infrastructure and a changing natural climate continue to outstrip the resource availability.

**Position Rules:** The City of Phoenix has 8 council members elected in 8 different districts, plus a mayor elected at-large and a council-appointed city manger. Ultimately, city residents' ability to use the primary resource is governed by this council.

**Boundary Rules:** Residents and firms in the city must file for permits and licensing with the city government in order to buy or build property, which indirectly effects use of the resource. Though there are no boundary rules directly governing the use of the resource.

**Choice Rules:** There are no choice rules relevant to the resource system.

**Aggregation Rules:** There are no aggregation rules relevant to the resource system.

**Scope rules:** There are several outcomes builders in the city must now achieve in order to conserve the resource:

"All buildings over 5,000 square feet shall provide the following: A minimum of 75 percent of public sidewalks shall be shaded [and] a minimum of 50 percent of all accessible public and private open space areas shall be shaded, of which 50 percent of the shade shall be provided by trees or trellised vines (City of Phoenix, Arizona 2015)."

"Alternative paving materials should be used on private property to reduce urban heat island effect, and to allow natural drainage and filtration (City of Phoenix, Arizona 2015)."

"Alternative paving materials such as permeable pavers, porous concrete or similar materials should be used for on-site hardscaping to reduce urban heat island effect, and to allow natural drainage and filtration (City of Phoenix, Arizona 2015)."

"The proposed building orientation should respect climate conditions by minimizing heat gain and considering the impact of shade on adjacent areas (City of Phoenix, Arizona 2015)."

"Windows placed above 30 feet in height should be designed to reduce summer solar heat gain and reflectivity. Windows shall have a Solar Heat Gain Coefficient (SHGC) of .40 or lower (City of Phoenix, Arizona 2015)."

However there are no scope rules for city residents in regards to the urban heat dissipation resource system, nor are there any choice scope governing use of the resource system by industry.

**Information Rules:** There are no information rules relevant to the resource system

**Payoff Rules:** Currently, builders must pay the costs associated with implementing the only required resource conservation infrastructure, though the benefits are experienced by every individual in the city.

## 1.5 Summary

A growing city and certain climate change induced warming makes appropriation of the capacity for the City of Phoenix to dissipate heat absolutely pressing. Framing the problem in the way done here exposes specific governance challenges, namely: the ability to measuring the city's capacity to dissipate heat, determining an equitable distribution of that resource, and monitoring and sanctioning that distribution. Managing these governance challenges while making considerations for the various resiliency trade-offs and feedback systems that heat mitigation interventions create will be essential for city planers moving forward.

## References:

City of Phoenix, Arizona. (2015, July 1). Zoning Ordinances of the City of Phoenix, Arizona. Retrieved December 5, 2015, from http://www.codepublishing.com/AZ/phoenix/?PhoenixZNT.html