Adapting To Extreme Heat

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Overview

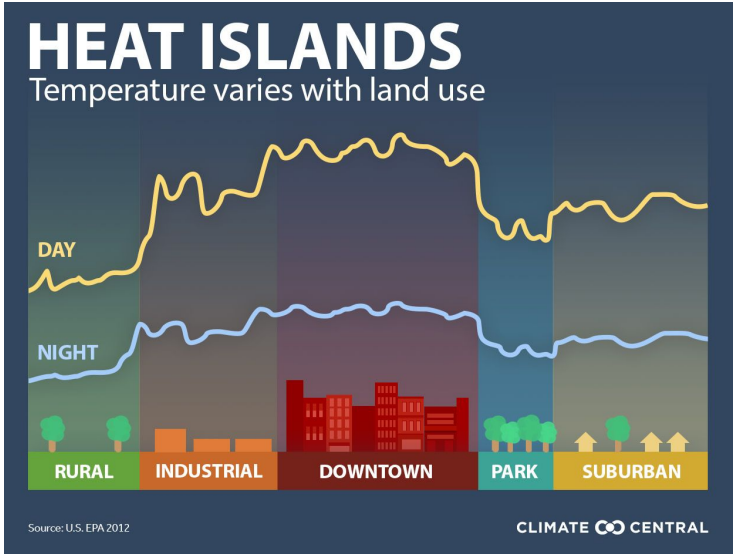
1. Why extreme heat is a major issue (Urban Heat Island Effect)
2. How it impacts the health of humans and the environment
3. Introduction to 3 adaptation strategies that can be used to minimize the effects of extreme heat
    a. Pros and cons
4. Conclusion: Why these designs are considered adaptation strategies and cost
5. What can we do?

01

Why extreme heat is a major issue

The Urban Heat Island Effect

- The UHI Effect is a noticeable increase in temperatures in urban areas compared to their surrounding suburban areas
- This is caused by the replacement of vegetation with highly absorbent (low-albedo) materials like asphalt, buildings, and other infrastructures
- These infrastructures absorb heat that would otherwise have been reflected by the vegetation. This heat makes the material hotter, and it reradiates that heat which makes the surrounding atmosphere hotter
- There are many simple and effective ways to deal with UHI, and some more complex. However, neither is being implemented at this time



Meg Calkins *Cooling the Blacktop*
https://www.jstor.org/stable/44681298

02

Impacts on human health and the environment

Impacts on the environment

The Southwest continues to increase in temperature with parts of the region reaching the world's highest temperatures recorded

- Droughts and competing water demands in this area pose a serious threat to the nation's agriculture and food security
- Tree death and increase in wildfires threaten people and their homes
- Melting of land ice and thermal expansion of ocean water raises sea levels
- Increased carbon dioxide emissions have caused water acidity off the coast of California to increase 25% to 40% from the preindustrial era to the early 2000s

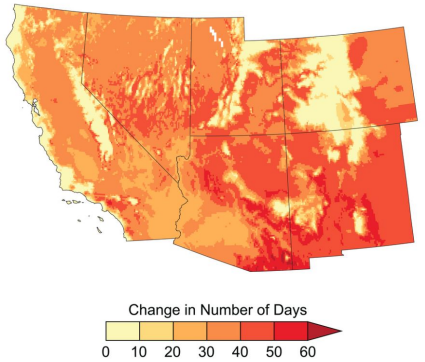
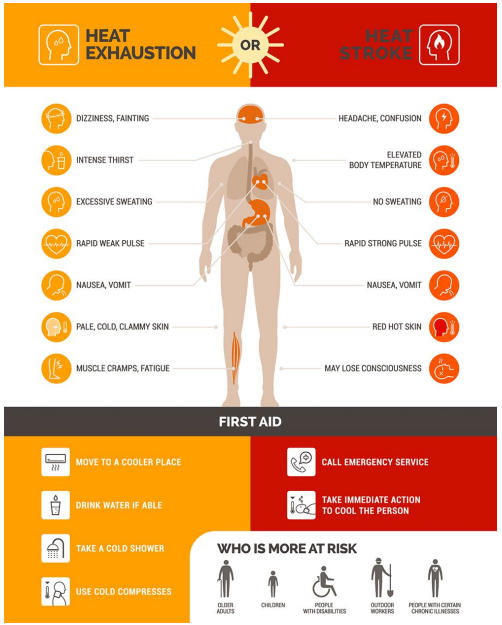


Figure 25.10: Under the higher scenario (RCP8.5), extreme heat would increase across the Southwest, shown here as the increase in the average number of days per year when the temperature exceeds 90°F (32°C) by the period 2036–2065, compared to the period 1976–2005.[23] Heat waves increase the exposure of people to heat stroke and other illnesses that could cause death.[30] Source: adapted from Vose et al. 2017.[23]

https://nca2018.globalchange.gov/chapter/25/

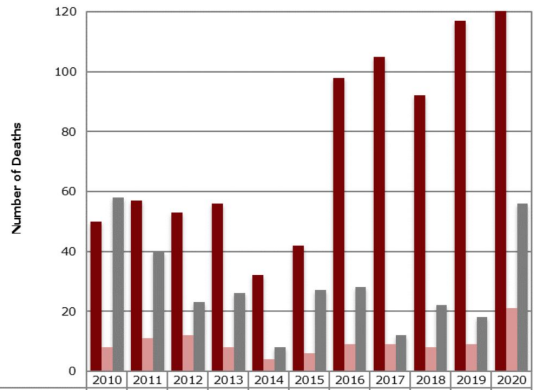
Impacts on human health



("Heatstroke," n.d.)

- Can lead to heat stress conditions such as heat stroke, heat exhaustion, heat cramps, and heat rashes
- Increased respiratory problems from breathing in hot, humid air
- Increased death rates due to heat waves

Deaths from Exposure to Excessive Natural Heat* occurring in Arizona by State or Country of Residence and Year, 2010-2020



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Arizona	50	57	53	56	32	42	98	105	92	117	206
Other U.S. states or Canada	8	11	12	8	4	6	9	9	8	9	21
Mexico, Central or South America	58	40	23	26	8	27	28	12	22	18	56

https://pub.azdhs.gov/health-stats/report/heat/heat2020.pdf

03

Adaptation strategies

Green Roofs

Green roofs provide shade, reduce surrounding air temperature, and assist with water supplies

Water Usage

Better water usage technique could save water during drought caused by extreme heat

AC Usage

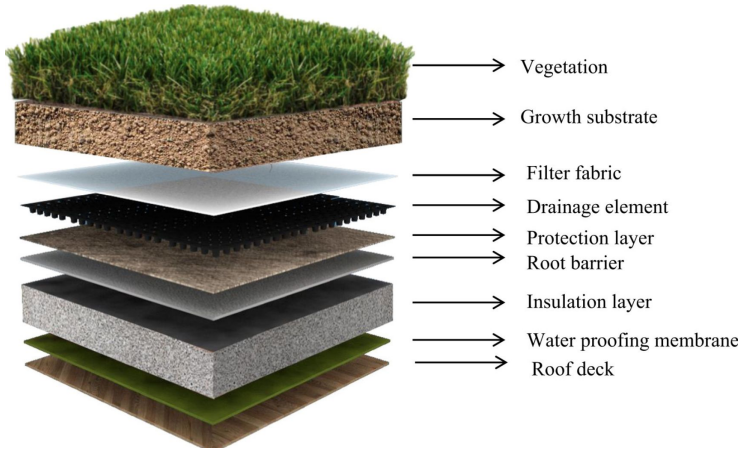
ACs add HFCs to the atmosphere, making it even hotter. Combined with other techniques, AC usage can be decreased

Green Roofs

What are green roofs and how do they work?

- A roof is when a roof of a building that is partially or completely covered with vegetation and growing medium
- They absorb natural rainwater and sunlight to produce essential energy for vegetation on top. The vegetation can then absorb carbon dioxide and produce oxygen, acting as a carbon sink.

    - Intensive green roof : complex version
        - More structural support, expensive, more maintenance
    - Extensive green roof: simpler version
        - Less structural support, less expensive, less maintenance



Green Roofs: Pros and Cons

Benefits

- Cooling Effect
- Reduces Urban Heat Island Effect
- Improves Energy Efficiency
- Water Quality Benefits
- Increases Biodiversity
- Aesthetically Pleasing

Disadvantages

- Expensive
  - $\$25\text{-}30/ft^2$
  - Additional $\$35/ft^2$ if replacement is needed
- Not compatible with all buildings
- Installation depends on roof

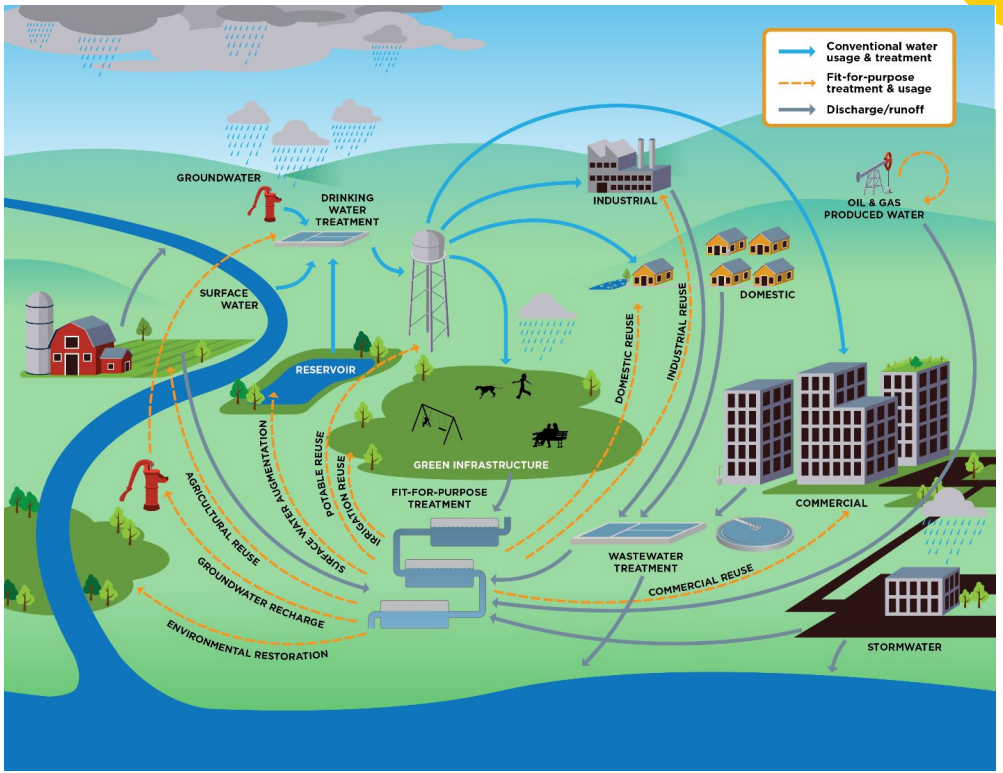
Practical ways to access clean water

SOLUTION

- Water recycling

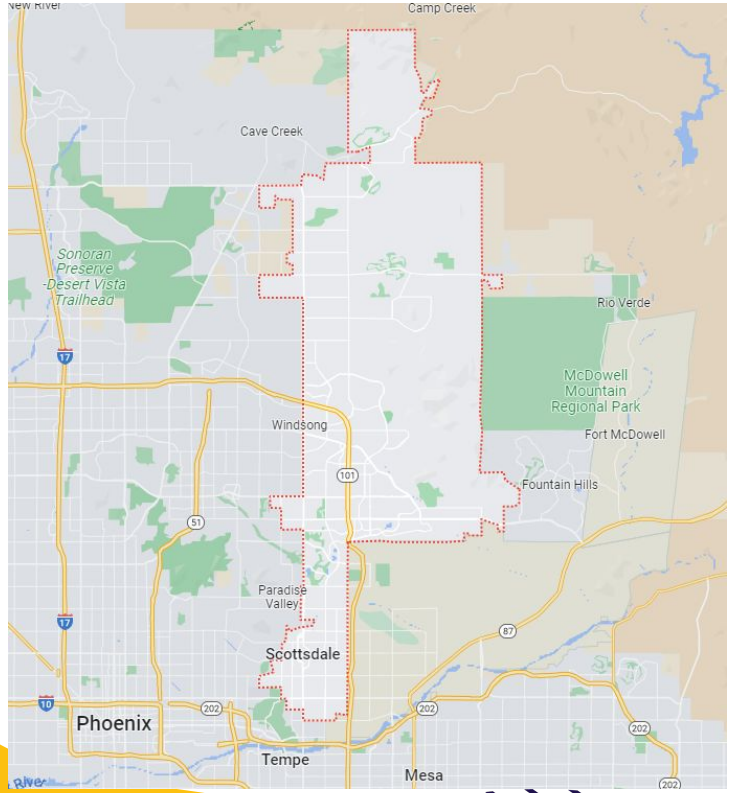
What is water recycling

Water recycling reclaims water from a variety of sources then treats and reuses it for beneficial purposes such as agriculture and irrigation, potable water supplies, groundwater replenishment, industrial processes, and environmental restoration.



https://www.epa.gov/waterreuse/basic-information-about-water-reuse

Why water recycling



Pros:

- Cooling effect
- Reducing energy consumption
- Drought resilience
- Conservation of water resources

Water recycling challenges

Financial reason:

cost high for building and maintenance

Health concern:

not properly treated recycling water might be harmful

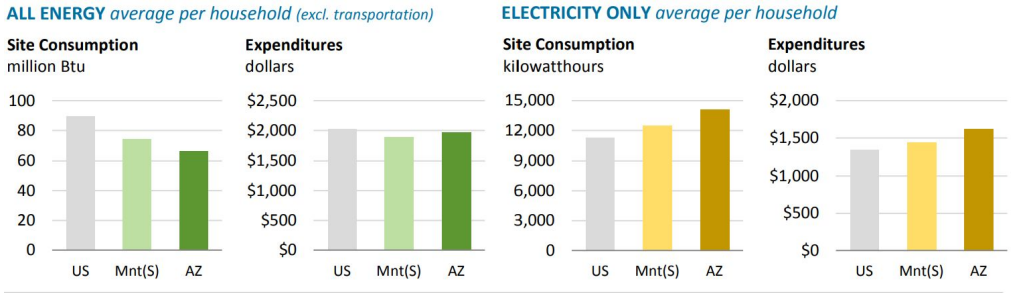
Public perception:

Using recycled water, especially as drinking water, requires overcoming public opinion

AC Usage

AC Usage in Arizona

- As a surprise to no one, Arizona residents frequently use their AC. In fact, Arizona households use a fourth of their electricity on AC alone
- The EIA conducted a survey in 2009 that concluded that although Arizona homes consumed 26% less energy than the average U.S. household, their high dependence on AC makes their average electricity consumption higher



The US Energy Information Administration
Household energy use in Arizona

Do ACs really cool us off?

- ACs remove hot air and replace it with cold air. The cold air goes inside, and hot air goes outside
- But this hot gas makes people feel hotter, so they turn on the AC, this creates a positive feedback loop
- Now imagine this across the entire world

Pros & cons to AC improvements

Benefits

- Cost (long run)
- Creates a positive feedback loop
- Heat deaths will decrease
- Decrease in HFCs in the atmosphere

Disadvantages

- As with every other group, high upfront cost
- Some improvements to ACs are still in their infancy

What would we save?

- Sense Labs conducted a survey of 15,000 homes and concluded that in a cold state like New York, if a fifth of homes with high AC use optimized their ACs and matched it to a fifth of the homes with the lowest AC energy use, 8% of all US residential electricity would be saved.
    - This is just in a cold state. In Arizona, the benefits would be amplified
- This would create:
    - $15.3 billion saved annually
    - 115 billion kilowatt hours potentially saved annually
    - 52M tons of carbon emissions could be avoided annually

Hence, the social cost of Carbon would be 52M x $51 = 2.652 Billion dollars of carbon emissions will be saved

George Zavaliagkos & Mahesh Sastry, Sense Labs *Using home energy monitoring technology to assess residential air conditioning*

04
Conclusion

Applying Adaptation Strategies

- Urban Heat Island Effect in Phoenix, AZ.
- Three Adaptation Strategies
  - Green Roofs
  - Water Recycling
  - AC Efficiency
- Individuals, businesses, and governments work together for implementation

05

What can we do?

As individuals and as a community

Legislation

- This is the most important part because if legislation doesn't go through, nothing can get started
  - We need people in office who are firm in their beliefs and understanding of climate change and want to do something about it
  - Person(s) has to be patient and willing to listen to what scientists are saying and be able to translate it to political speech
- This person not only needs to have these qualities, but must understand what people want. He/she can do this by going out to the streets and seeing what people are having problems with

What can we do right now?

- Decrease our dependence on AC
    - This is either unrealistic, or very difficult to pull off, but it must be done. It's predicted that ACs will become as ubiquitous as phones by 2050. This is what we as normal citizens can do right now. Researchers and scientists are trying to find new refrigerants that aren't harmful to the environment, but that's still in its infancy stage
- If not decrease our dependence,
    - Then let's at least use our smart thermostats and turn them off if we're not using them
- Add Green roofs on company roofs and other vegetation in poorer areas where the government will maintain them
    - Green roofs are great, but they're expensive and take a while to install
    - In addition to green roofs, we can add other vegetation like green walls, or just simply planting trees. Planting trees have a lot of benefits including shade
    - Many parts of Phoenix, especially the poor areas, don't have trees or anything to shade them from the sun. And many people don't have cars, so they're walking to work or waiting for the bus in the heat

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Questions?