

مؤتمر ومعرض الهندسة الخضراء  
(GREEN ENGINEERING CONFERENCE &  
EXHIBITION)

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Collaborative research between Qatar University and Portland State University

GREEN ENVIRONMENT, CLIMATE CHANGE, AND HEALTHY  
LIVING: THE CASE OF DOHA

البيئة الخضراء وتغير المناخ والحياة الصحية: حالة الدوحة

DR. SALIM FERWATI

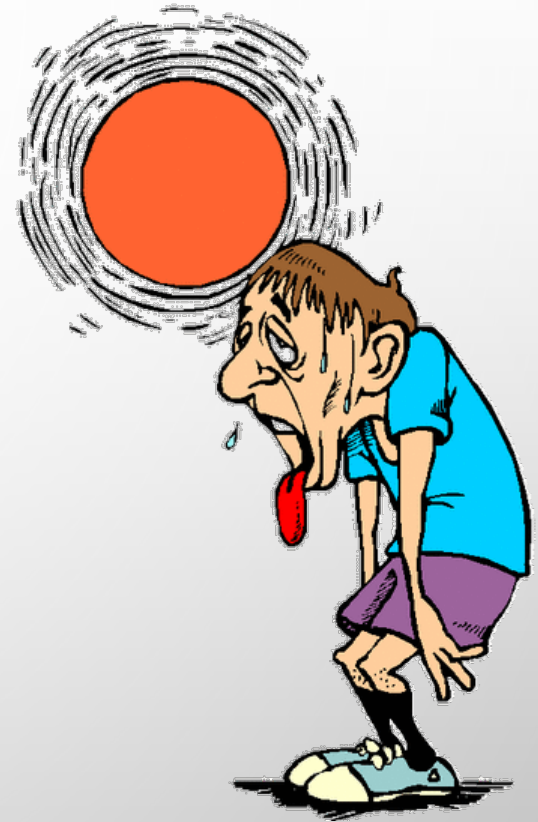
# WHAT IS HEALTHY ENVIRONMENT?

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- THE U.S. HEALTH CARE SECTOR IS HIGHLY INTERCONNECTED WITH INDUSTRIAL ACTIVITIES EMIT MUCH OF THE NATION'S POLLUTION TO AIR, WATER, AND SOILS.
- IN USA, NEGATIVE ENVIRONMENTAL AND PUBLIC HEALTH OUTCOMES WERE ESTIMATED THROUGH ECONOMIC INPUT-OUTPUT LIFE CYCLE ASSESSMENT (EIO-LCA) MODELING USING NATIONAL HEALTH EXPENDITURES (NHE) FOR THE DECADE 2003–2013 AND COMPARED TO NATIONAL TOTALS.
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- CONCERTED EFFORTS TO IMPROVE ENVIRONMENTAL PERFORMANCE OF HEALTH CARE COULD REDUCE EXPENDITURES DIRECTLY THROUGH WASTE REDUCTION AND ENERGY SAVINGS, AND INDIRECTLY THROUGH REDUCING POLLUTION BURDEN ON PUBLIC HEALTH, AND OUGHT TO BE INCLUDED IN EFFORTS TO IMPROVE HEALTH CARE QUALITY AND SAFETY.

AN ARTICLE WAS PUBLISHED AS PART OF A [SPECIAL SERIES](#) FOR WORLD HEALTH DAY AND IN ADVANCE OF THE [2013 SKOLL WORLD FORUM](#). WATCH THE LIVE STREAM APRIL 10-12 BY [CLICKING HERE](#).

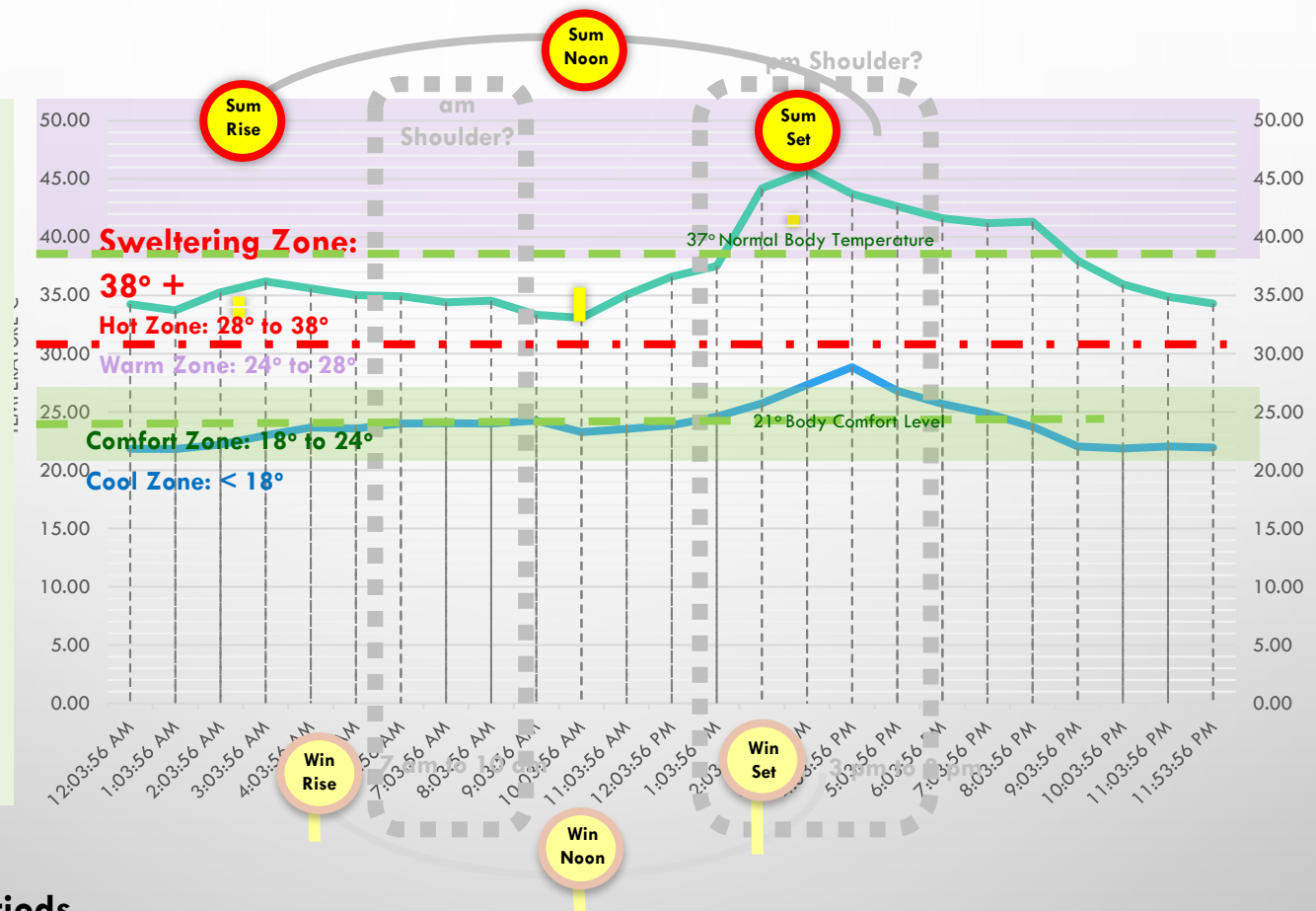
- THE LANCET, BRITAIN'S PREMIER HEALTH JOURNAL, CALLS **CLIMATE CHANGE "THE BIGGEST GLOBAL HEALTH THREAT OF THE 21ST CENTURY."**
- "WHAT HEALTH SCIENTISTS ARE TELLING US IS THAT CLIMATE CHANGE WILL BRING INCREASED ASTHMA, MORE VIRULENT ALLERGENS, MEDICAL EMERGENCIES FROM HEAT STRESS, THE SPREAD OF WATER- AND VECTOR-BORNE DISEASES AND INCREASED SEVERE WEATHER EVENTS.

- [HTTPS://WWW.FORBES.COM/SITES/SKOLLWORLDFORUM/2013/04/07/WHAT-DOES-CLIMATE-CHANGE-HAVE-TO-DO-WITH-HEALTH-CARE/#7946E55D7915](https://www.forbes.com/sites/skollworldforum/2013/04/07/what-does-climate-change-have-to-do-with-health-care/#7946E55D7915)



**21 July  
Hottest Day**

**9 February  
Nice Day  
"National  
Sports Day"**

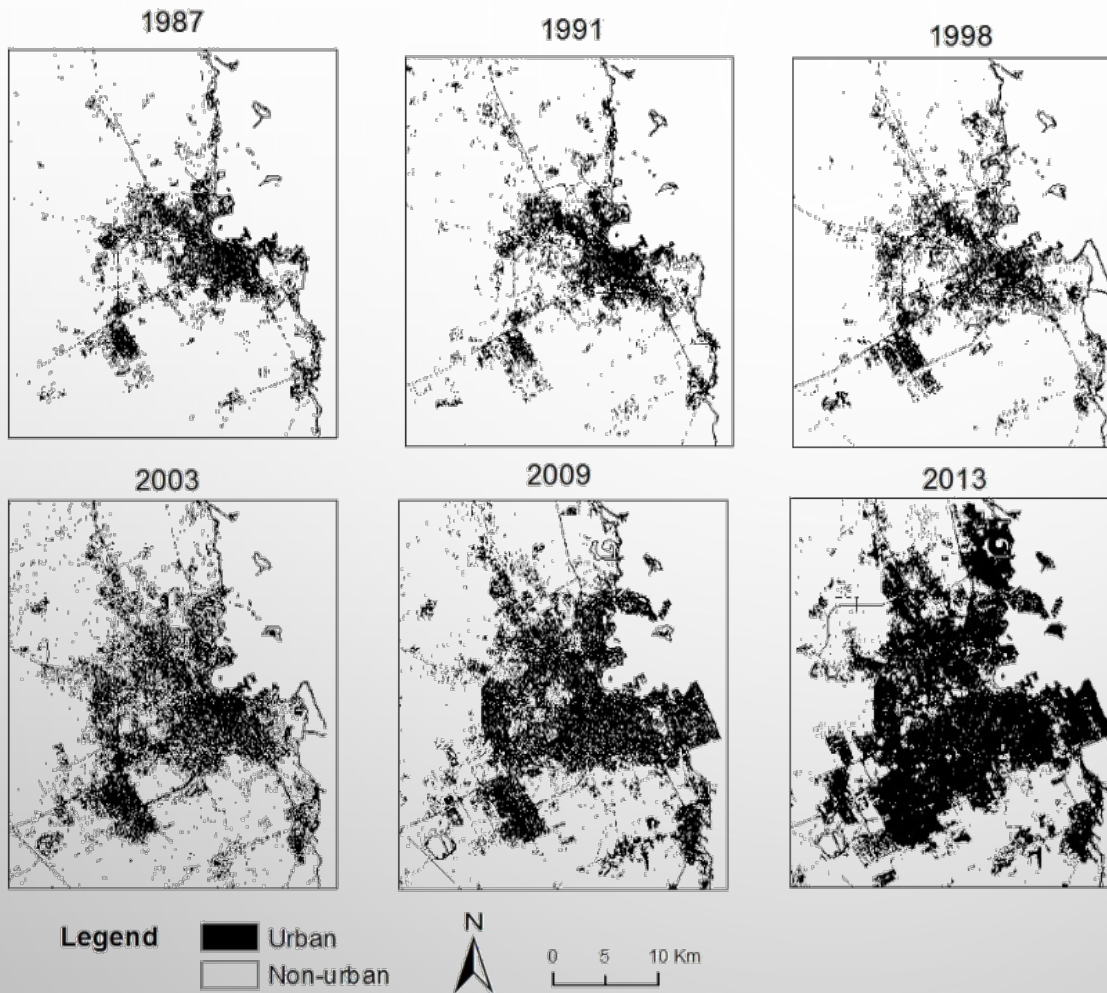


## Shoulder Periods

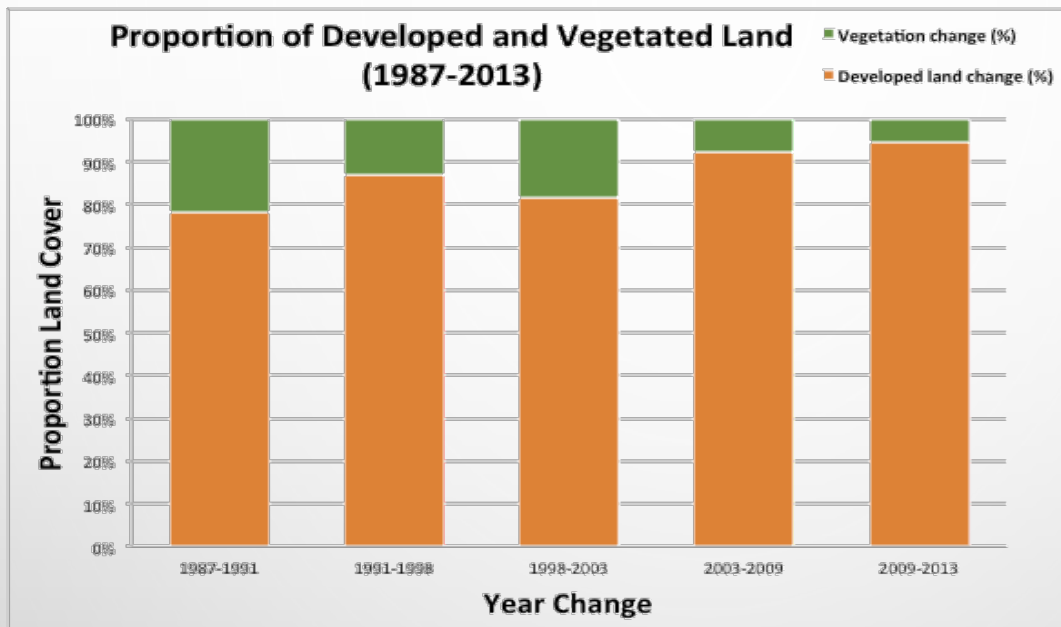
Shade or Materials Benefits?

# LEARNING OBJECTIVES

- UNDERSTANDING OF THE INFLUENCE OF BUILT FORM AND HUMAN ACTIVITY ON MICROCLIMATE
- UNDERSTANDING OF KEY ENVIRONMENTAL VARIABLES AFFECTING AIR TEMPERATURE IN URBAN ENVIRONMENTS
- DEVELOP KNOWLEDGE OF URBAN CORRIDORS AND SURROUNDING LAND USE CHARACTERISTICS IN DOHA



Land cover  
development  
from 1987 to  
2013

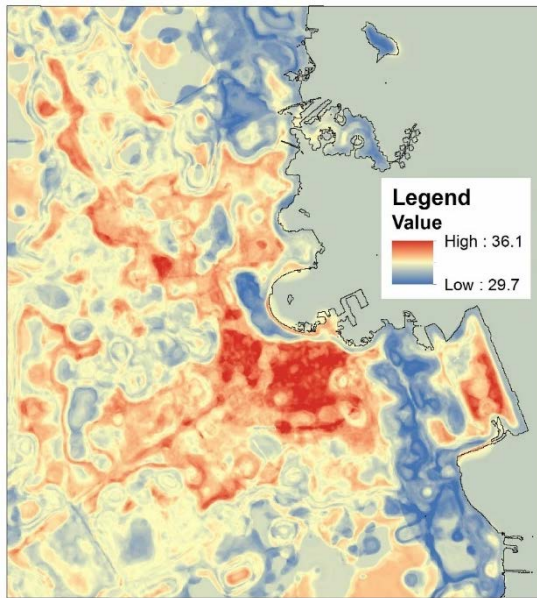


- AMOUNT & RATE OF CONVERSION TO DEVELOPED LAND IS ACCELERATING
- AMOUNT & PROPORTION OF VEGETATION IS DECREASING
- IMPLICATIONS ON ENVIRONMENTAL CONDITIONS?

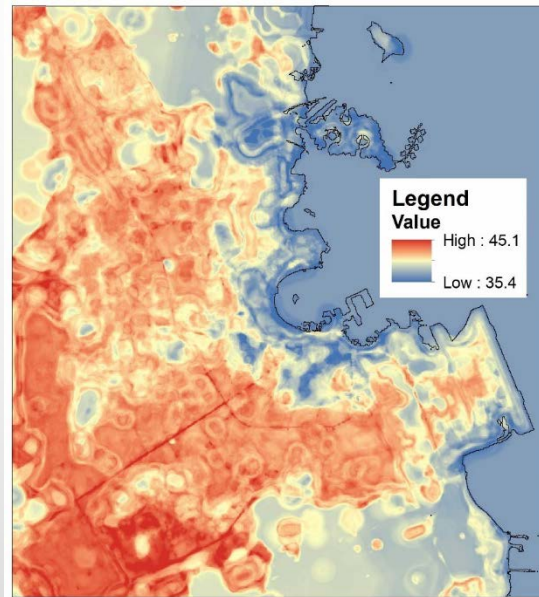
LAND COVER	YEAR				
	1987-1991	1991-1998	1998-2003	2003-2009	2009-2013
Converted to Developed Land (km)	18	53	53	90	131
Converted to Vegetation (km)	5	8	12	7	8



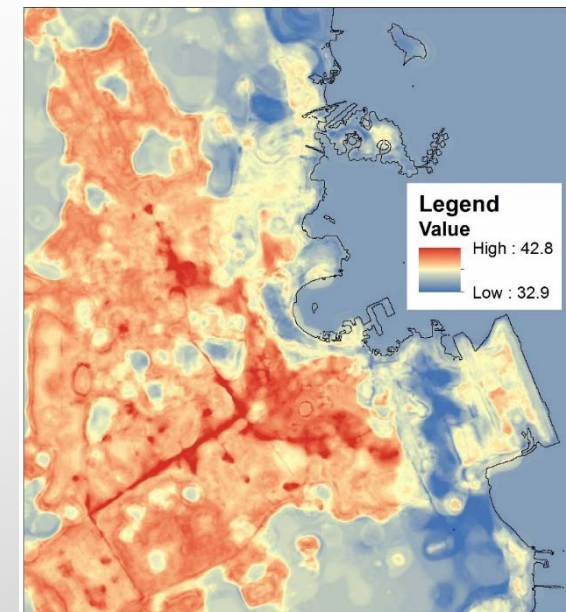
## Temperature Variation using Random Forest Method



6am



1pm



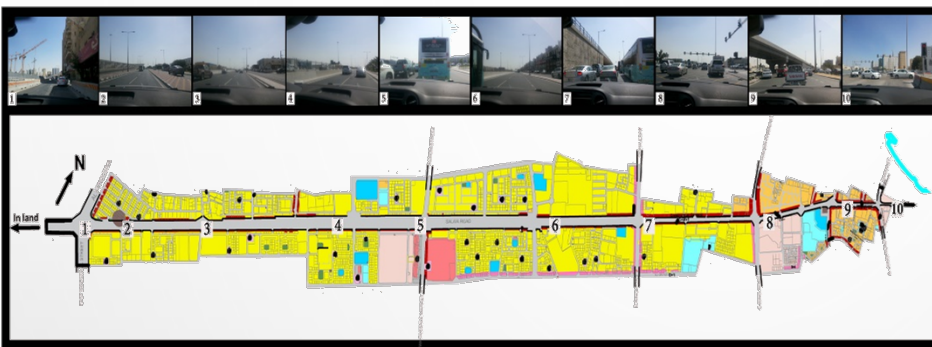
7pm

Using the traverse data, **spatial representations of temperature variability** for 8<sup>th</sup> and 9<sup>th</sup> of Sept at 7pm



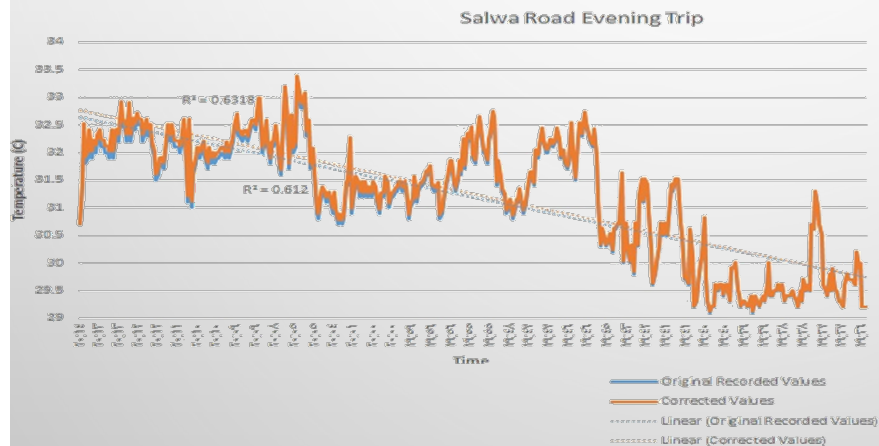
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## Towards a Strategy for Urban Climate Monitoring in the Region of Greater Cairo



### LEGEND

- Single Family (Attached/Detached)
- Multi Family Residential
- Commercial Office
- Commercial Souks/Shopping Center
- Commercial Frontage (Mixed Use)
- Industrial Light
- Industrial Heavy
- Public Institutions: Schools
- Public Institutions: Government
- Park / Recreation / Open Space
- Mosque
- Parking
- ★ Community Center
- Special Use District
- Utility



## Air Temperature Mobile Measurements

- 3 traverses per day (morning, mid-day, and evening)
- 4 days
  - April, Tues and Fri
  - July/Aug – Tues and Fri



# AIR TEMPERATURE

Point data  
aggregated into  
average over  
100m segments  
of roadway



Corridor Analysis

# BUILDINGS DATA



- Building Area
- Building Height – critical to allow calculation of built volume
- Vacant Plots

## Variables:

- 200 m – Building Count, Area, and Volume
- 400 m – Building Count, Area, and Volume



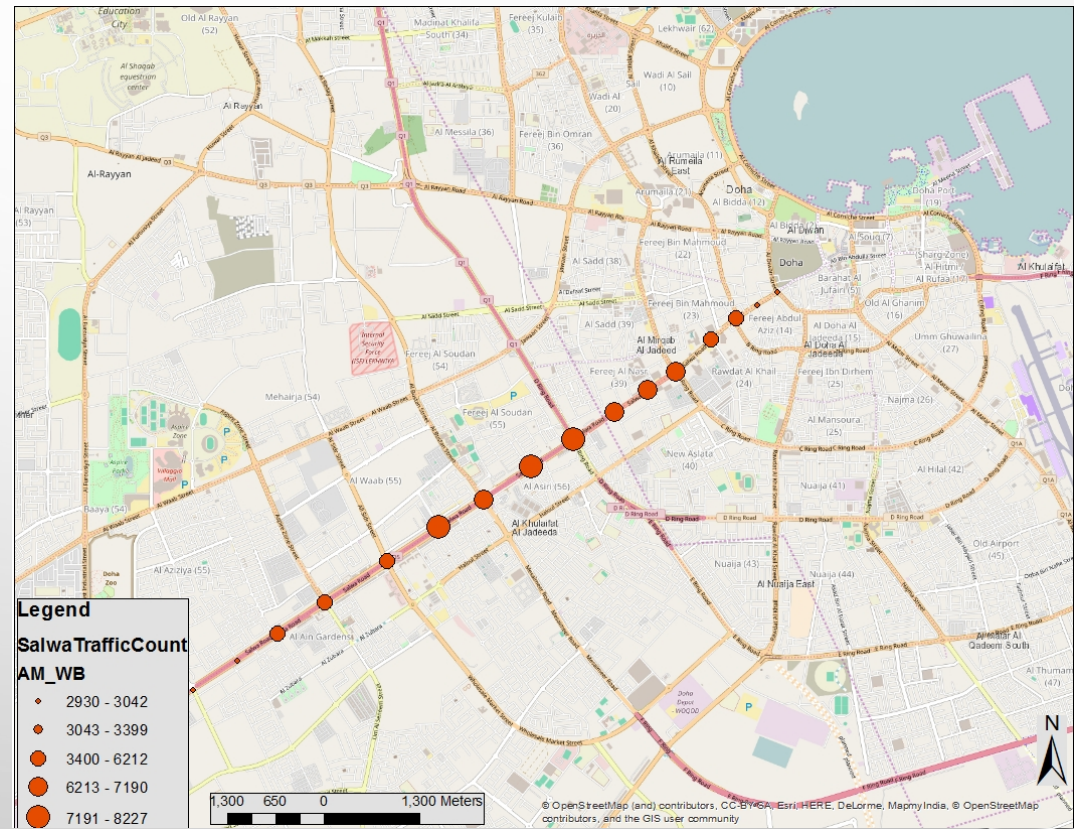
# TRAFFIC DATA

3 times of day:

- Morning
- Mid-day
- Evening

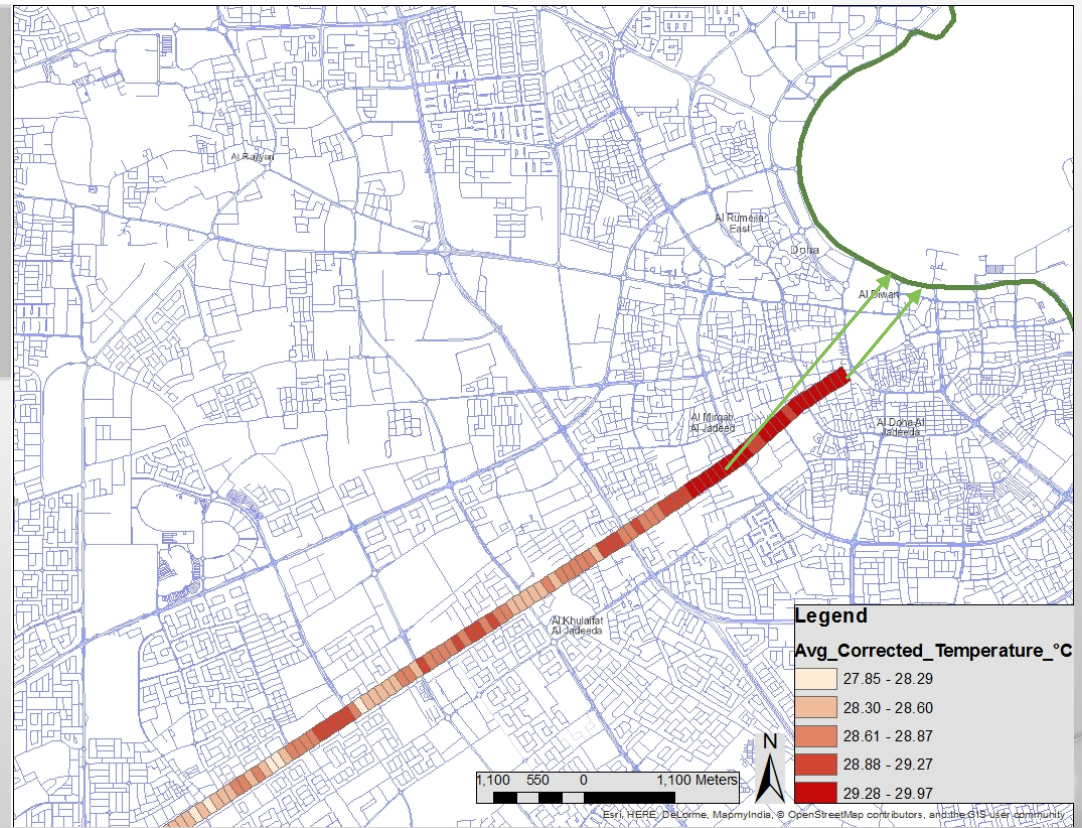
Volume:

- Eastbound
- Westbound
- Total



# DISTANCE TO COAST

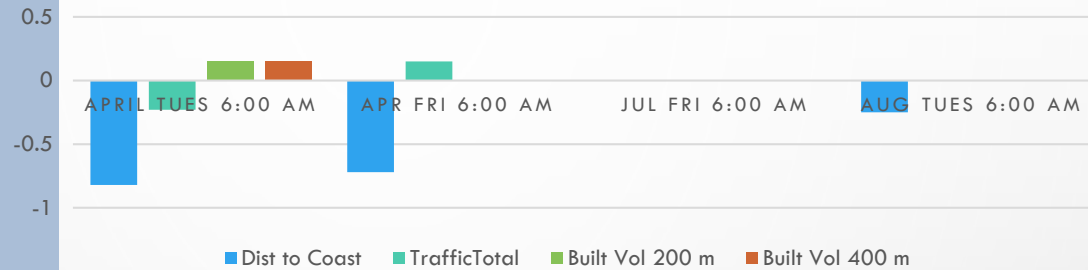
Each segment  
calculated for  
distance to coast  
(nearest straight-  
line)



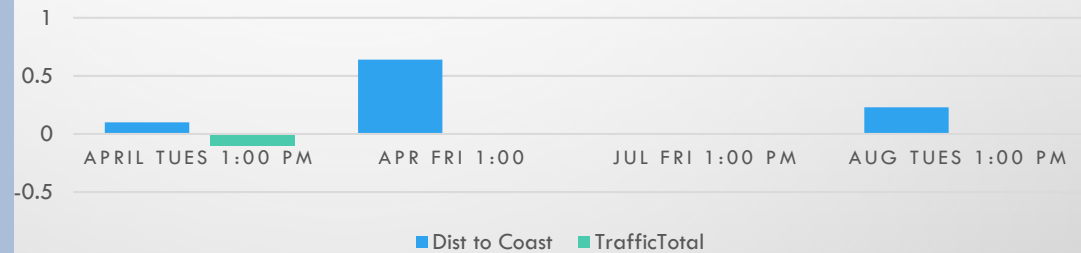


## CORRELATION RESULTS

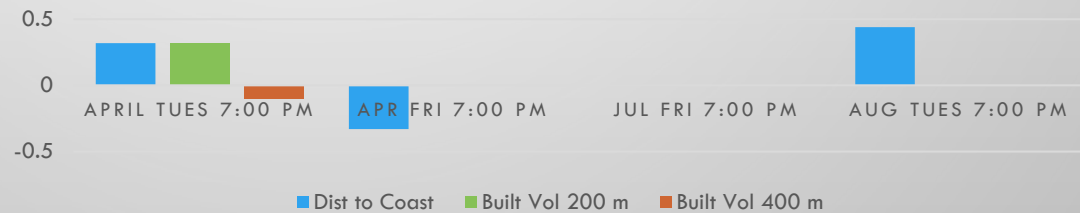
### MORNING TRAVERSES



### MID-DAY TRAVERSES

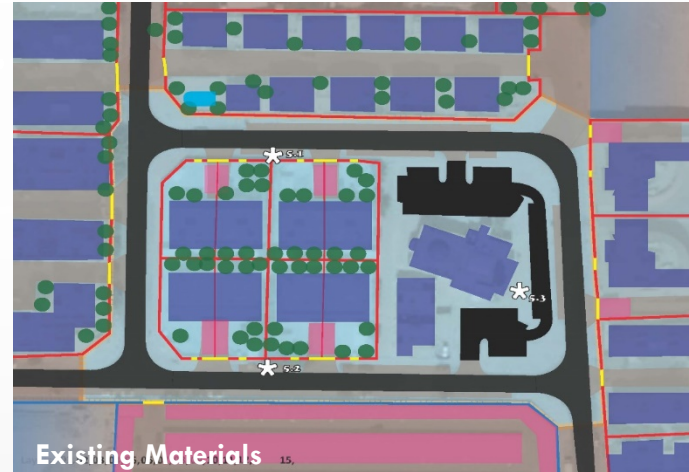
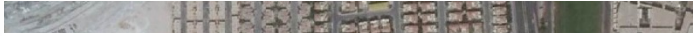


### EVENING TRAVERSES



# SUMMARY 1

- Research analyzed a corridor environment in Doha to determine variables in the surrounding built environment that may influence air temperature
- Tested variables of distance to coast, traffic volume, building count, area, and volume within 400m of the corridor
- Found that mornings in April showed a strong negative correlation with distance to coast, but trend reversed and showed positive correlations for evening (inland areas were warmer), while July/Aug correlations were not as strong
- Some small correlations with built volume at 200m and 400m in April morning and evening traverses
- Surprisingly, only small correlations with traffic volume



**Location:** Al Waab District, approximately 6.00 km inland SW from Doha Bay.

**Description:** 1.75 Ha. A small cluster of residential buildings within walled enclosures in a larger neighborhood of gated-compounds. The mosque serves the neighborhood and the adjacent retail/commercial zone. A community playground is not close and the sidewalks are not pedestrian-friendly.

## Urban Design Challenges – Developed Area



**Grey Vehicular Pavers**



**Green Pedestrian Pavers**



**Green Wall or Hedge**



**Shade Trees and Decorative Palms**

### **Optimum Transformation:**

Asphalt Streets and parking areas: **change to grey pavers**

Red Paver Pedestrian areas: **change to green pavers**

Masonry or Concrete Perimeter Walls: **install green plantings or replace with hedge and fence**

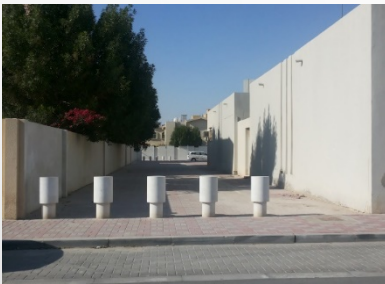
Sidewalks: **add Shade trees**





### **Pedestrian-Friendly Streets**

Trees cool pavements, parked cars, and sidewalks. Replace perimeter walls with dense Hedges.



### **Sikkat**

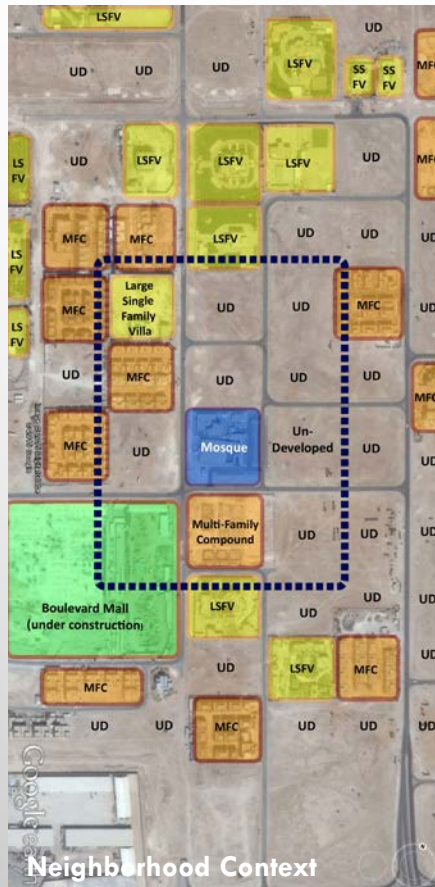
Perimeter hedges and trees shade and cool pedestrian passageways, increase visual appeal, and encourage pedestrian use.



### **Shaded Parking Lots**

Trees shade and cool pedestrian pathways, sidewalk areas, streets, and parking areas. Palms call attention to special places.





**Location:** Umm Salal Mohammad District, 11.00 km inland from Lusail.

**Description:** 45 Ha. Residential area with Mosque. No community facilities. Mall under construction.



## Urban Design Challenges – *Undeveloped Area*



### **Pedestrian-Friendly Streets**

Inviting people of all ages to get out of doors

### **Bicycleways**

Safe routes for transport and exercise

### **Arcades**

Shaded passages for shoppers and slow walkers

### **Courtyards + Parks**

Shaded landscaped meeting and play places

### **New Social Medium**

Community Facilities and places to go and meet others in person – easily accessible on foot, by bicycle, or by car.



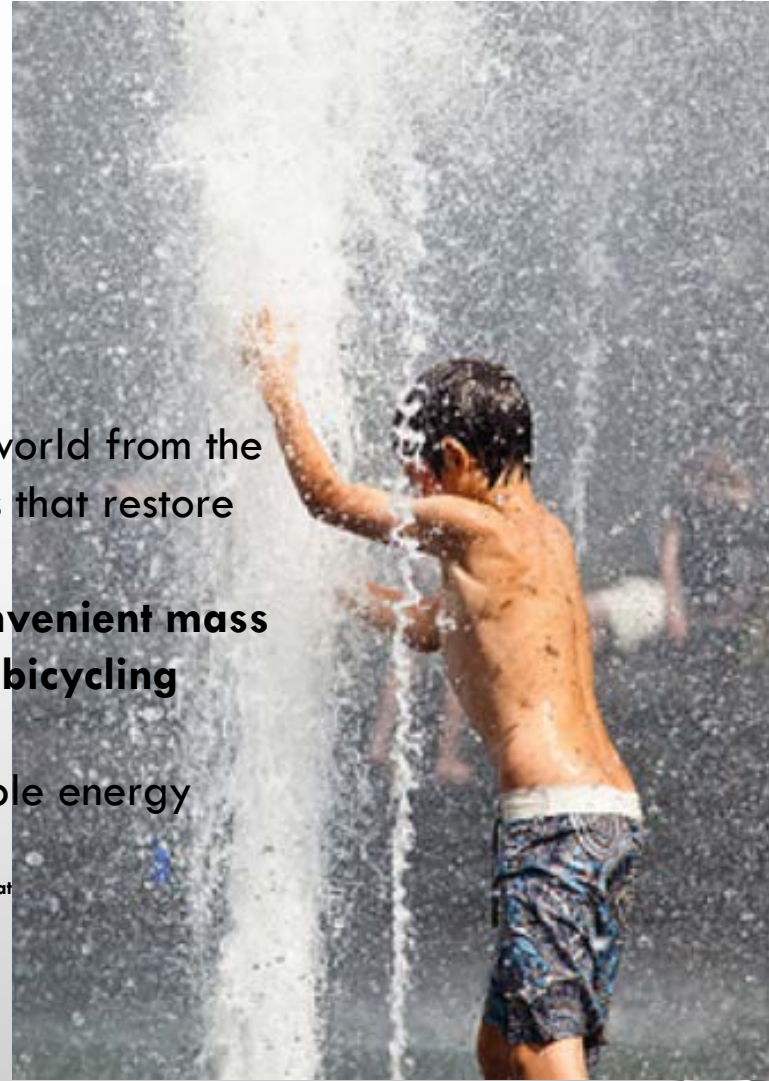
# SUMMARY 2.

## A. Land cover affect microclimate temperature

B. “Action to reduce climate change: To protect our world from the health effects of climate change, we must take steps that restore the climate. This includes:

1. **Planning future growth to ensure efficient, convenient mass transit. Where conditions permit, walking and bicycling more....”**
2. Switching from fossil fuels to safe clean renewable energy sources like sun, water and wind.

PHYSICIANS FOR SOCIAL RESPONSIBILITY (accessed 17 April 2019\_ **Climate Change and Health: The Effects of Heat**  
<http://www.psr.org/environment-and-health/climate-change/results-impacts/heat-effects-fact-sheet-0514.pdf>



# RESPONSIVE DESIGN FOR HOT ARID CLIMATE

- Eco-district concept is a responsive solution for the negative consequences of climate change.
- It provides a sustainable built environment by mitigating the harsh hot days
- A first step in estimating the potential for mitigating heat is to understand the spatial and temporal variation of air temperature throughout the city.
- Then develop predictive models that relate physical characteristics to the corresponding variations in near-surface air temperatures.
- Assess the extent to which the built environment, including vegetation, affect intra-urban variability of temperature in Doha, Qatar.

## Research Outline

1. Exploring the Spatial and Temporal Variation of Air Temperature in the Extreme Desert Climate of Doha
2. Forecasting Land Use change in Doha using Land Transformation Model
3. Estimating Urban Air and Surface Temperatures: ENVI-met microclimate modelling
4. Corridor analysis of air temperature: Al-Rayyan Rd. and Salwa Rd.

### **ENVI-met Analyses of Surfaces and Materials**

Measure potential reduction to Urban Heat Island Effect at Case Study sites using alternative surface materials and by adding shade trees

### **Temperature + Air Quality Analyses of the Urban Environment**

Summarize Weather and Air Quality Data from 13 sites throughout Doha

Compare the Salwa Road and Al Rayyan Road Corridors

### **Final Documentation**

Report on Study, Process, Case Study sites, Findings, Recommendations, and Suggested Next Steps. Submission scheduled for 31 December 2016

**What is Next?**



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