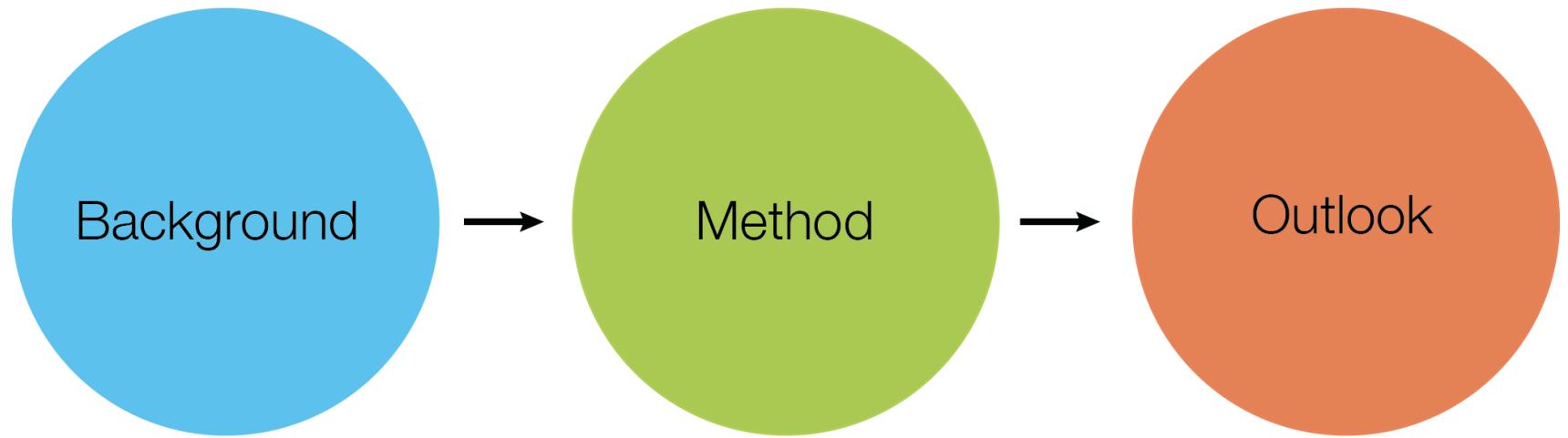


First results of the data acquisition and analysis of microclimate conditions in Barranquilla, Colombia

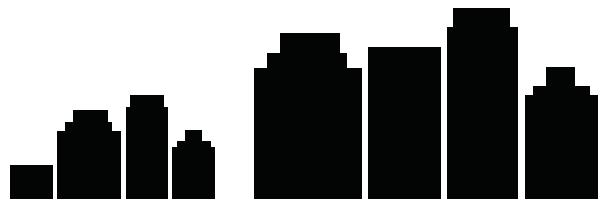
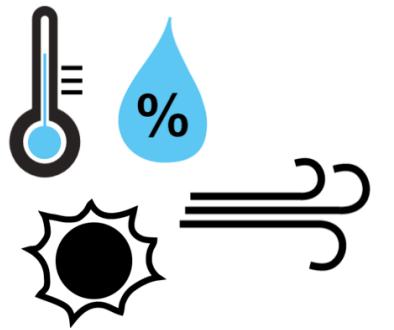
23.07.2015
tapias@arch.ethz.ch

Estefania Tapias, Andreas Matzarakis, Gerhard Schmitt

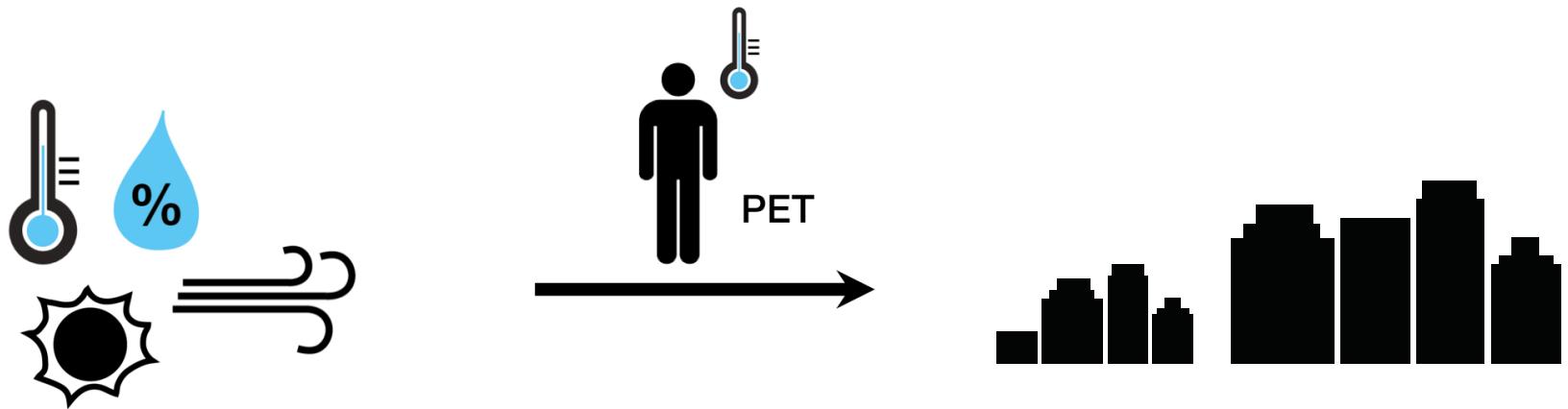
Content



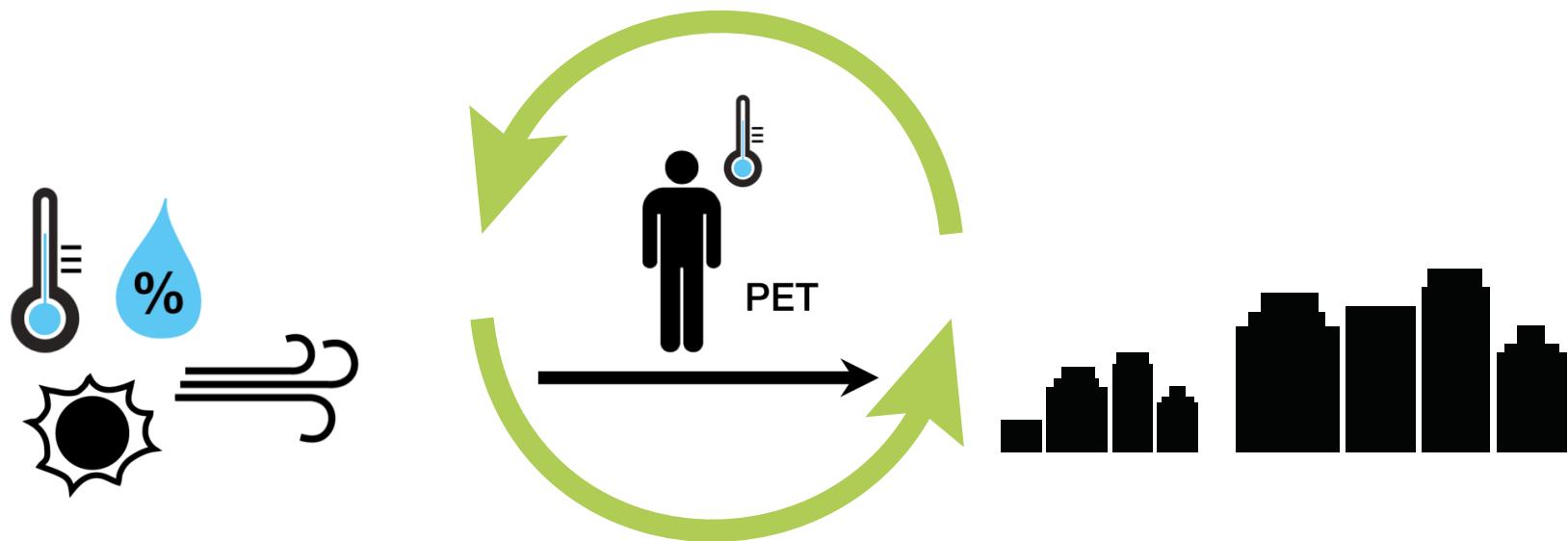
Introduction



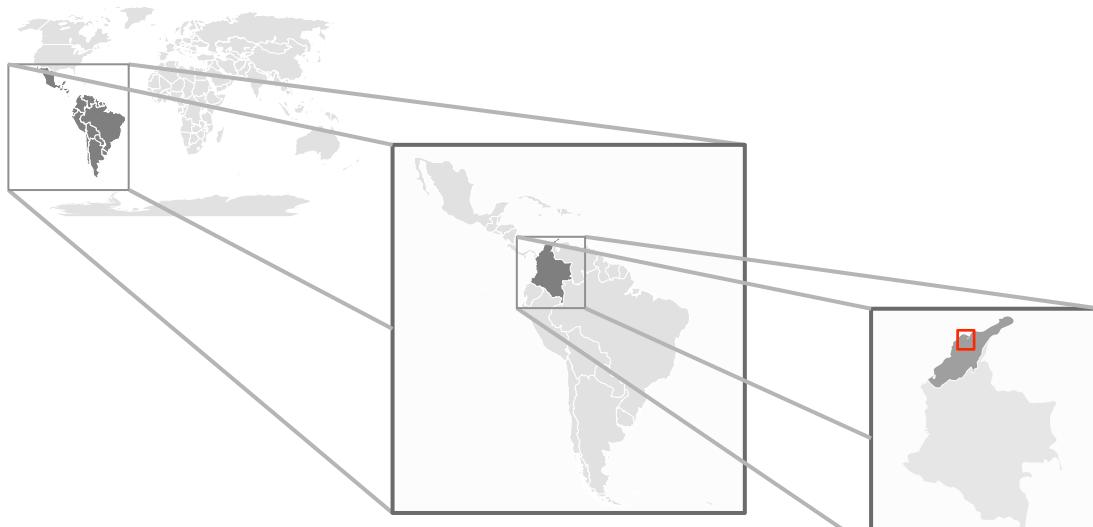
Introduction



Introduction



Case study



Barranquilla,
Atlántico

Inhabitants: 1,836,331

Population density: 6,918.71 inhabitants per square kilometer.

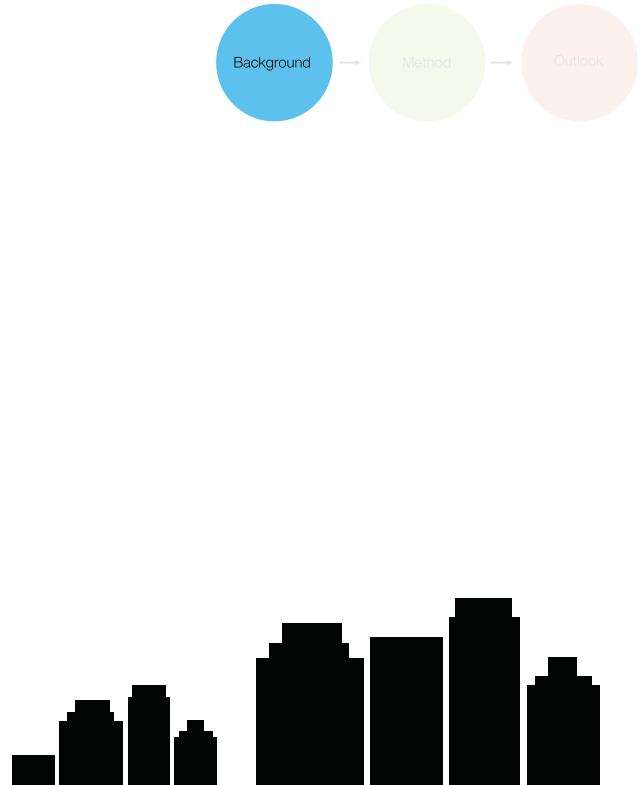
Metropolitan area: 166 km²

Tropical savanna climate

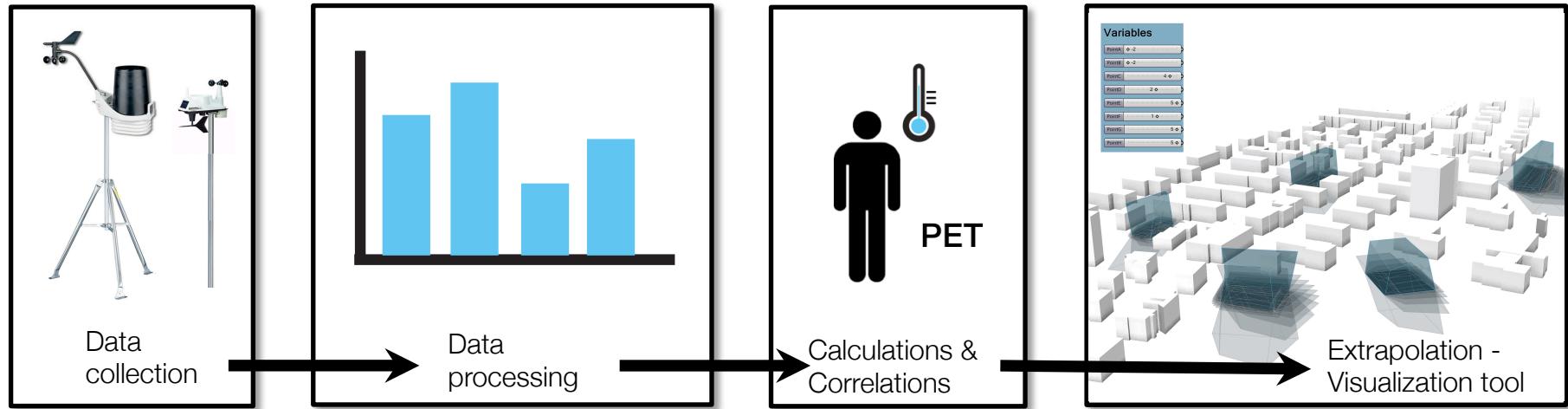
Pronounced dry season

The average temperature is 28.4 °C

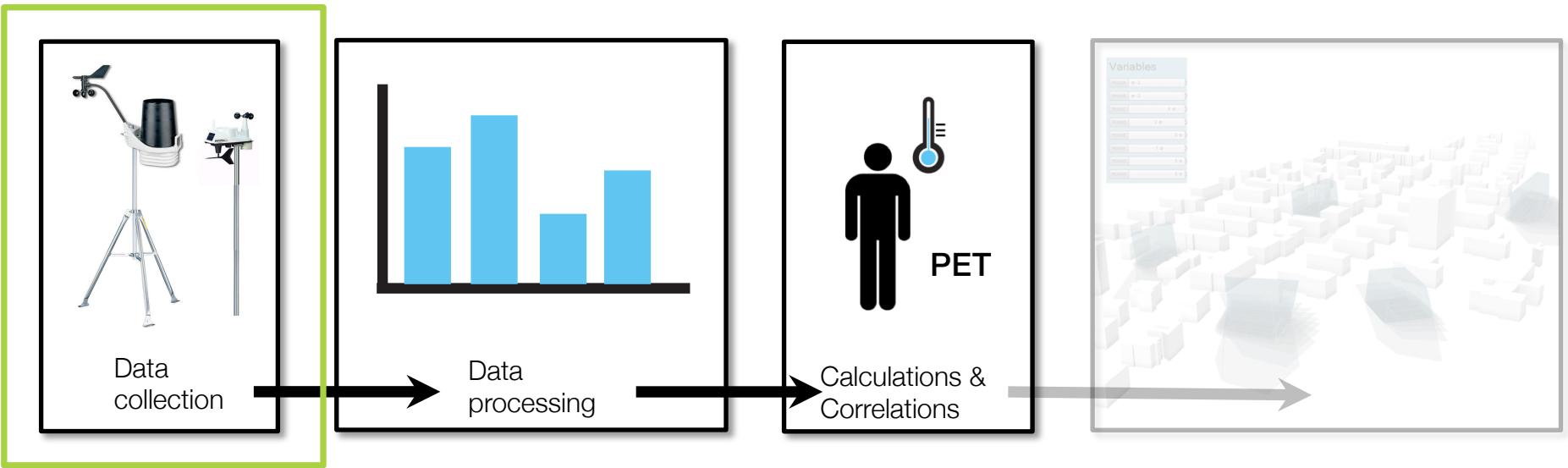
Daytime temperature usually remains around 32 °C



Context – overall research



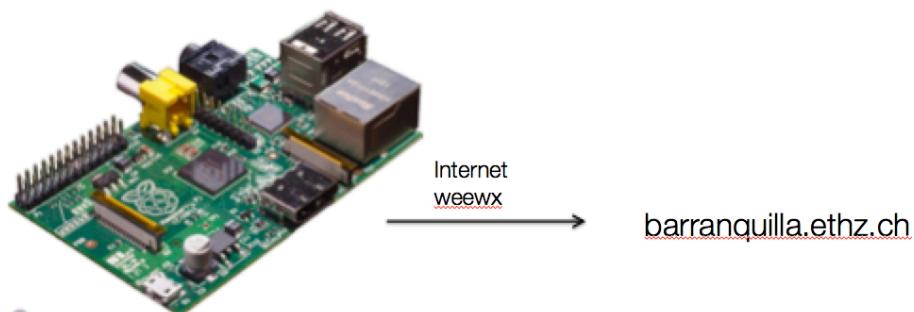
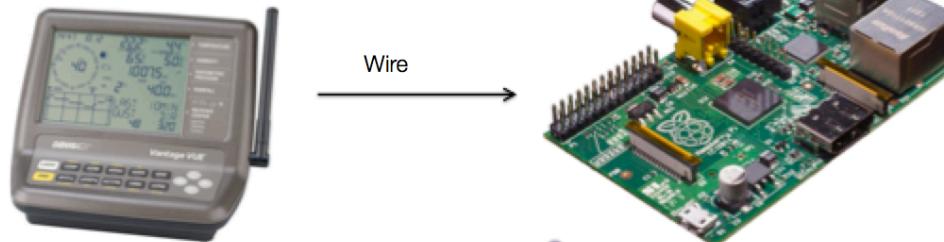
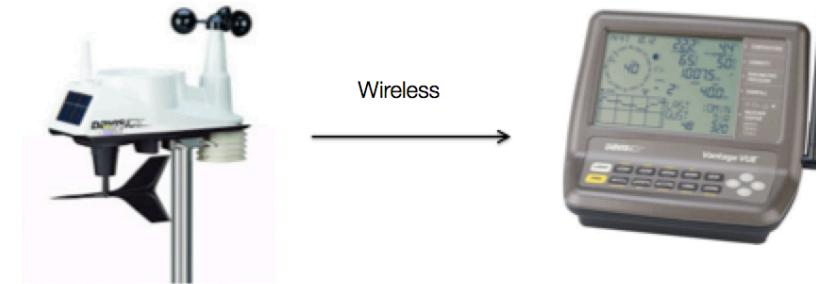
Context – overall research



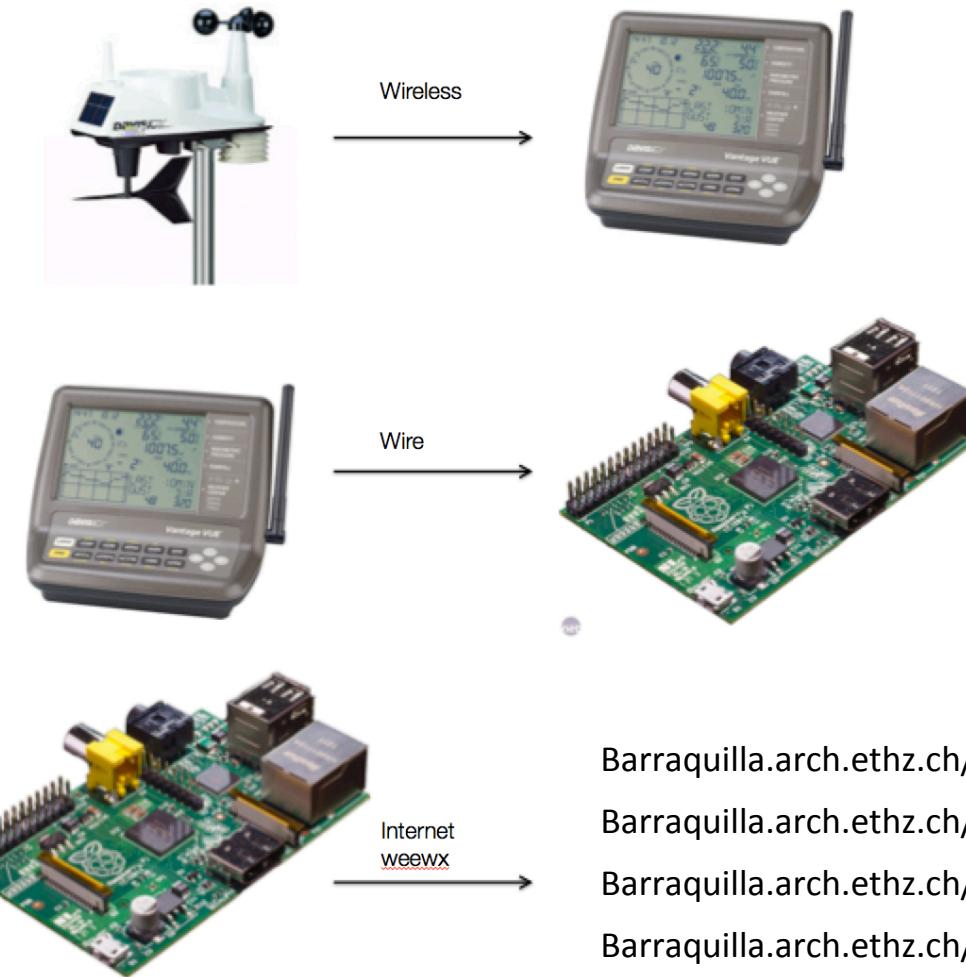
Measurement network



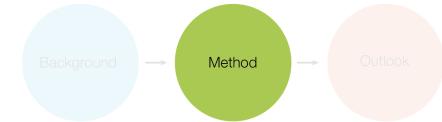
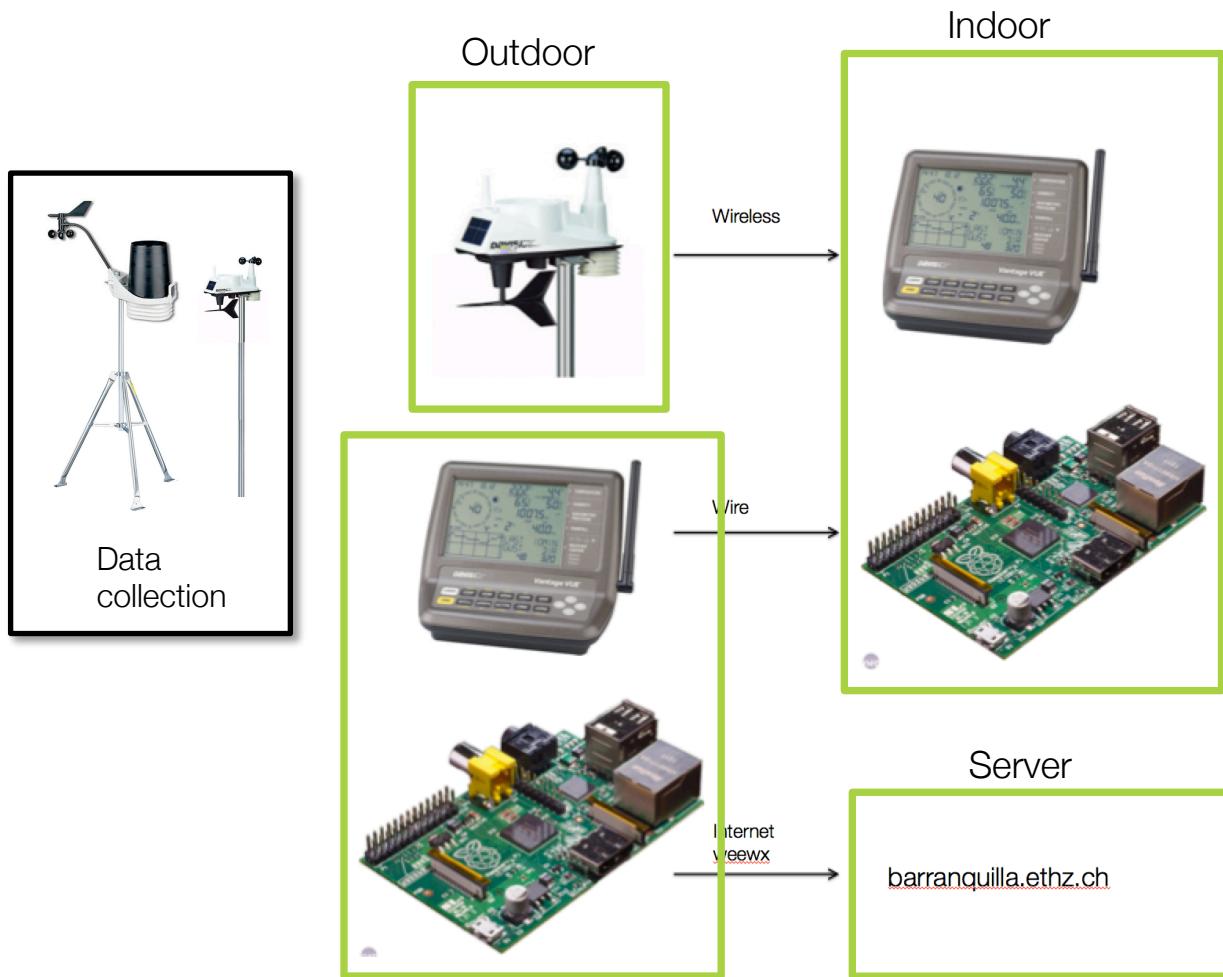
Measurement network



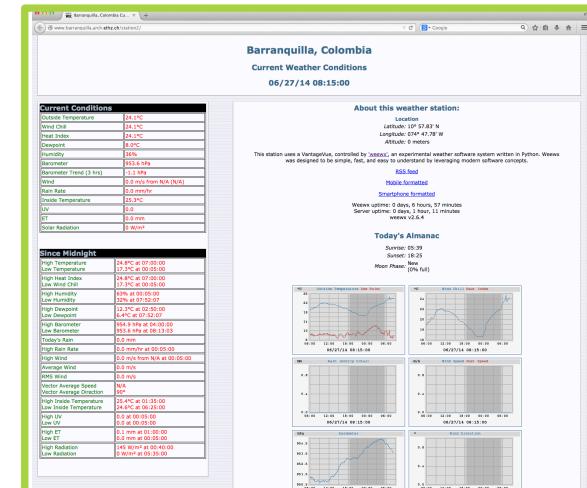
Measurement network



Measurement network



Barraquilla.arch.ethz.ch/station1
Barraquilla.arch.ethz.ch/station2
Barraquilla.arch.ethz.ch/station3
Barraquilla.arch.ethz.ch/station4
Barraquilla.arch.ethz.ch/station5



Measurement network



Barranquilla, Colombia

Current Weather Conditions

07/22/15 12:15:00

Current Conditions

| | |
|-------------------------|------------------------|
| Outside Temperature | 31.9°C |
| Wind Chill | 31.9°C |
| Heat Index | 39.2°C |
| Dewpoint | 25.0°C |
| Humidity | 67% |
| Barometer | 1007.6 hPa |
| Barometer Trend (3 hrs) | -0.7 hPa |
| Wind | 3.1 m/s from 315° (NW) |
| Rain Rate | 0.0 mm/hr |
| Inside Temperature | 28.2°C |
| UV | 8.5 |
| ET | 0.0 mm |
| Solar Radiation | 928 W/m² |

About this weather station:

Location

Latitude: 10° 57.83' N

Longitude: 074° 47.78' W

Altitude: 27 meters

This station uses a VantagePro2, controlled by '[weewx](#)', an experimental weather software system written in Python. Weewx was designed to be simple, fast, and easy to understand by leveraging modern software concepts.

[RSS feed](#)

[Mobile formatted](#)

[Smartphone formatted](#)

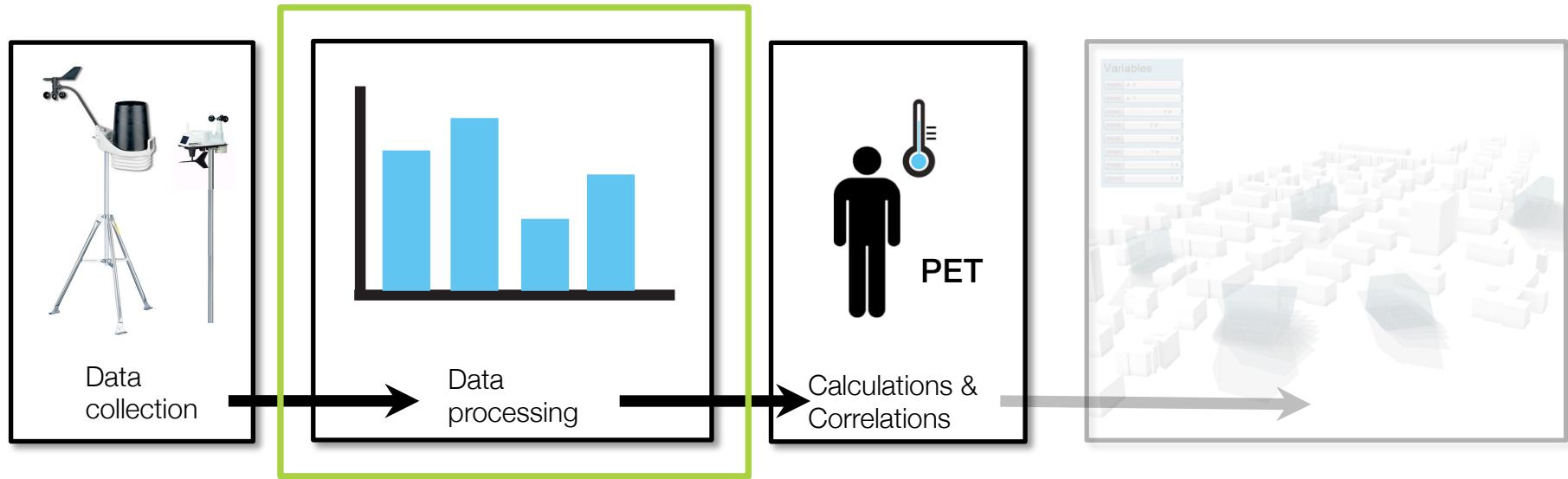
Weewx uptime: 41 days, 19 hours, 57 minutes

Server uptime: 41 days, 19 hours, 56 minutes

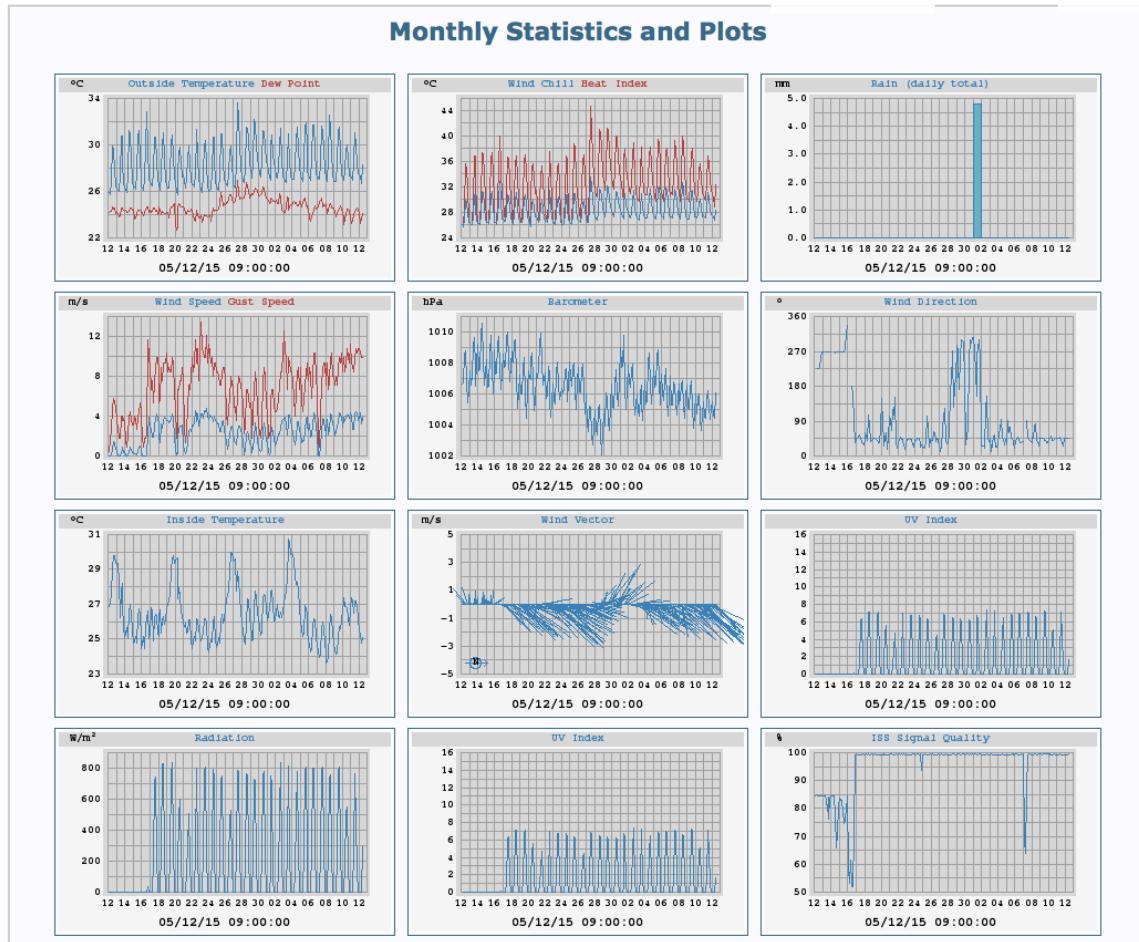
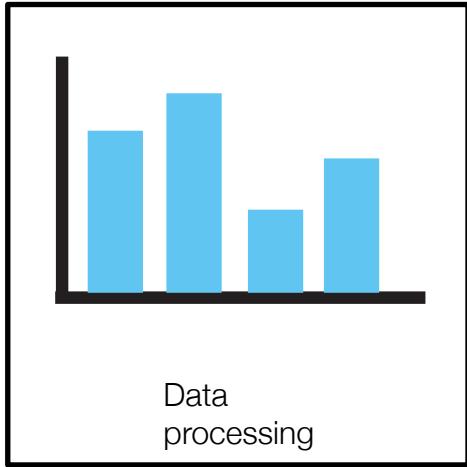
weewx v2.6.4

Todav's Almanac

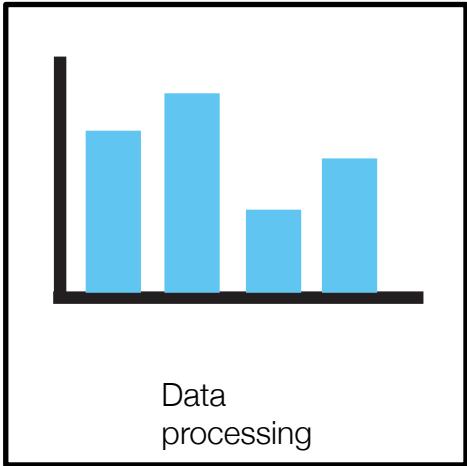
Context – overall research



Data processing

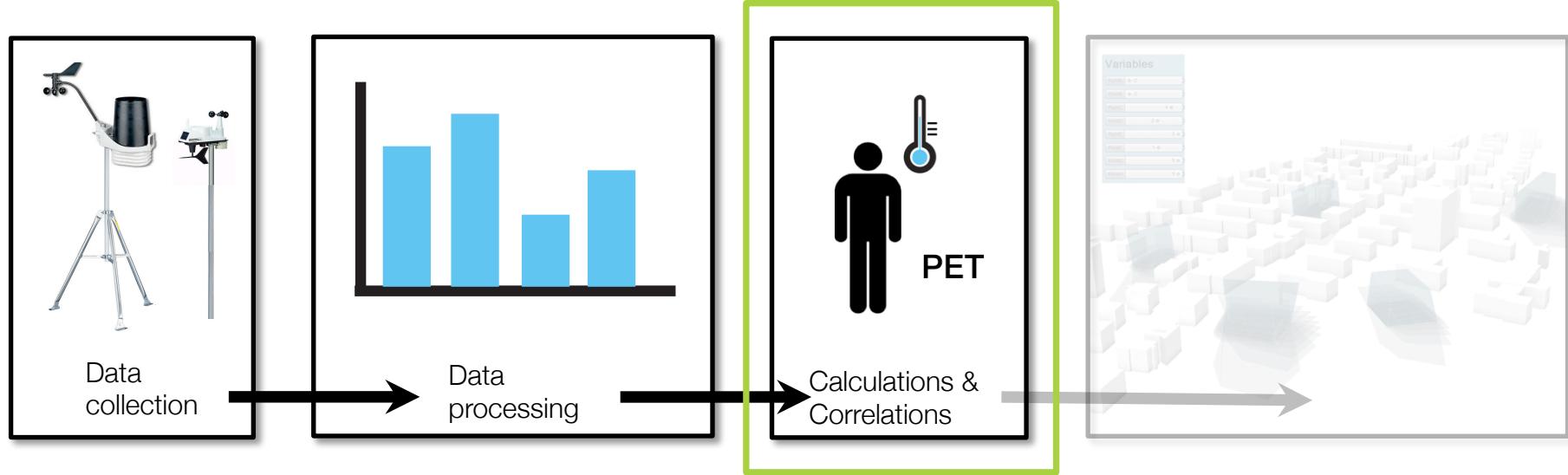


Data processing

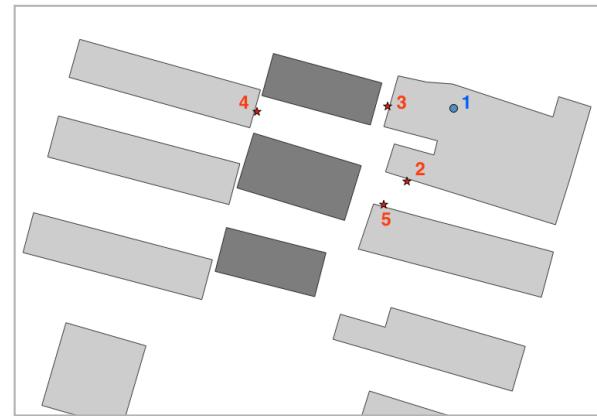
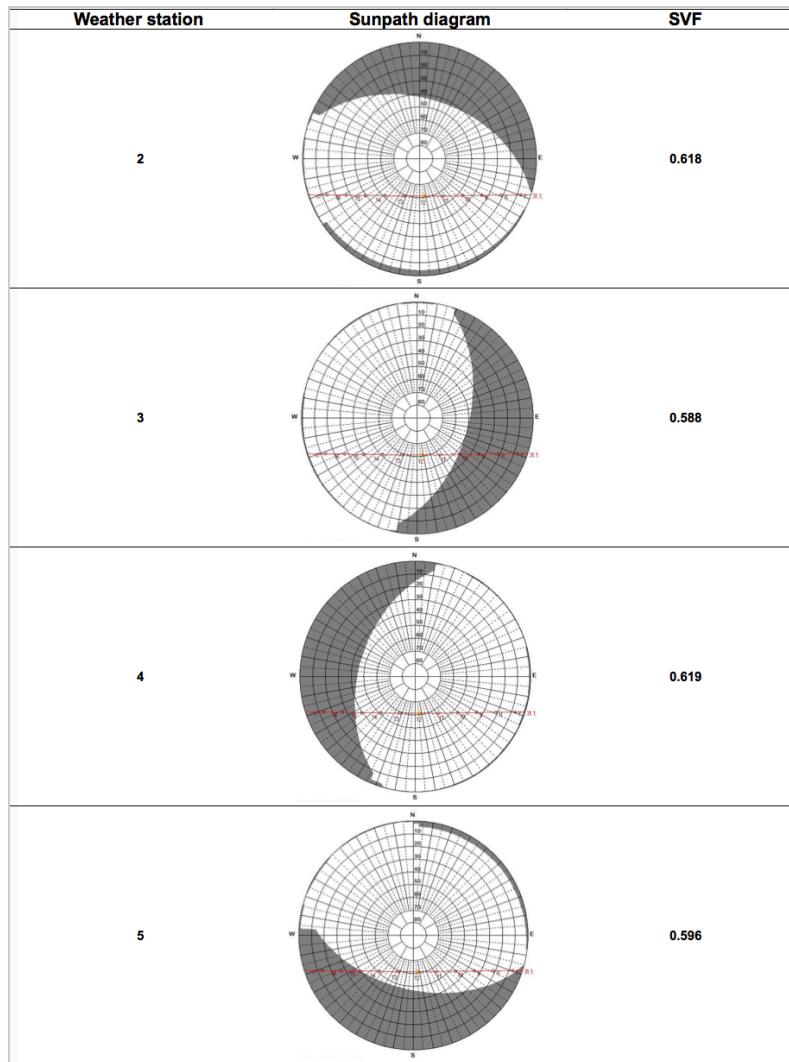
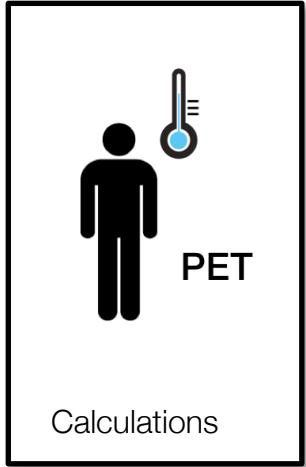


| This Month | |
|--------------------------|--|
| High Temperature | 33.7°C at 05/08/15 11:01:10 |
| Low Temperature | 25.9°C at 05/01/15 08:05:41 |
| High Heat Index | 42.5°C at 05/08/15 11:09:20 |
| Low Wind Chill | 25.9°C at 05/01/15 08:05:41 |
| High Humidity | 93% 05/01/15 07:41:43 |
| Low Humidity | 58% 05/08/15 10:53:58 |
| High Dewpoint | 26.6°C 05/03/15 08:59:35 |
| Low Dewpoint | 22.8°C 05/10/15 03:10:07 |
| High Barometer | 1010.4 hPa at 05/01/15 09:08:01 |
| Low Barometer | 1003.4 hPa at 05/10/15 15:08:00 |
| Rain Total | 4.8 mm |
| High Rain Rate | 48.0 mm/hr at 05/01/15 07:12:49 |
| High Wind Speed | 12.5 m/s from 69° at 05/02/15 22:17:35 |
| Average Wind | 2.9 m/s |
| RMS Wind | 3.1 m/s |
| Vector Average Speed | 2.7 m/s |
| Vector Average Direction | 35° |
| High Inside Temperature | 30.8°C at 05/03/15 13:53:59 |
| Low Inside Temperature | 23.4°C at 05/08/15 06:18:57 |
| High UV | 9.5 at 05/02/15 11:48:21 |
| Low UV | 0.0 at 05/01/15 00:00:04 |
| High ET | 0.7 mm at 05/06/15 12:00:00 |
| Low ET | 0.0 mm at 05/01/15 00:05:00 |
| High Radiation | 1037 W/m² at 05/02/15 11:14:01 |
| Low Radiation | 0 W/m² at 05/01/15 00:00:04 |

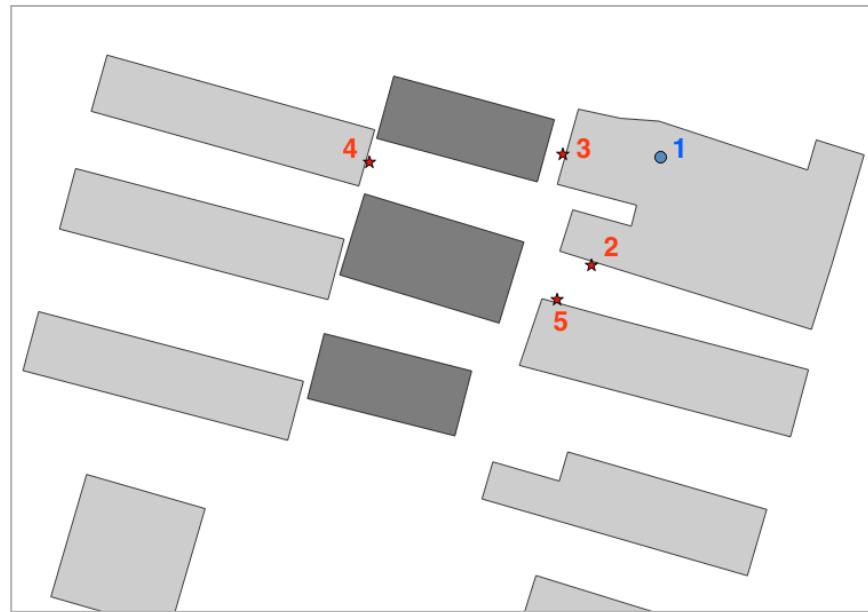
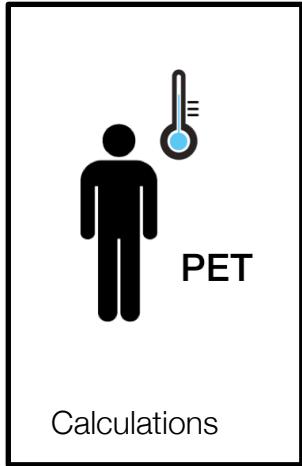
Context – overall research



PET calculations



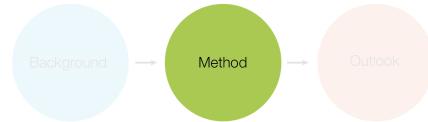
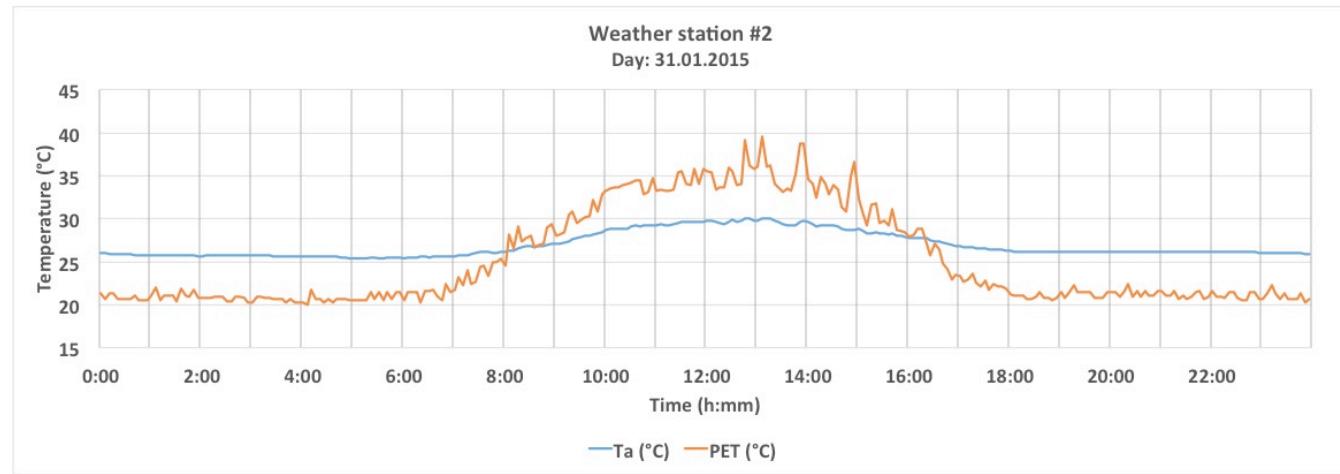
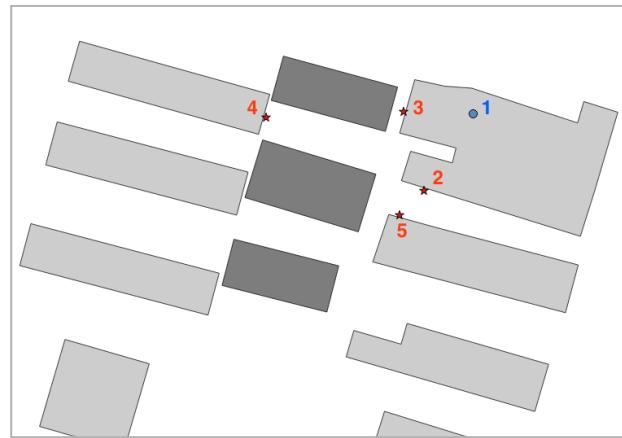
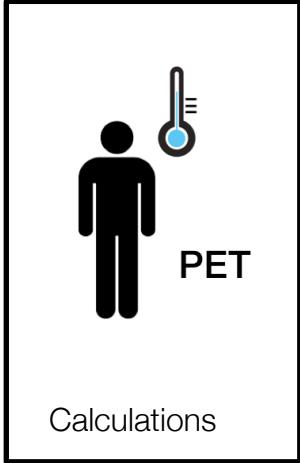
PET calculations



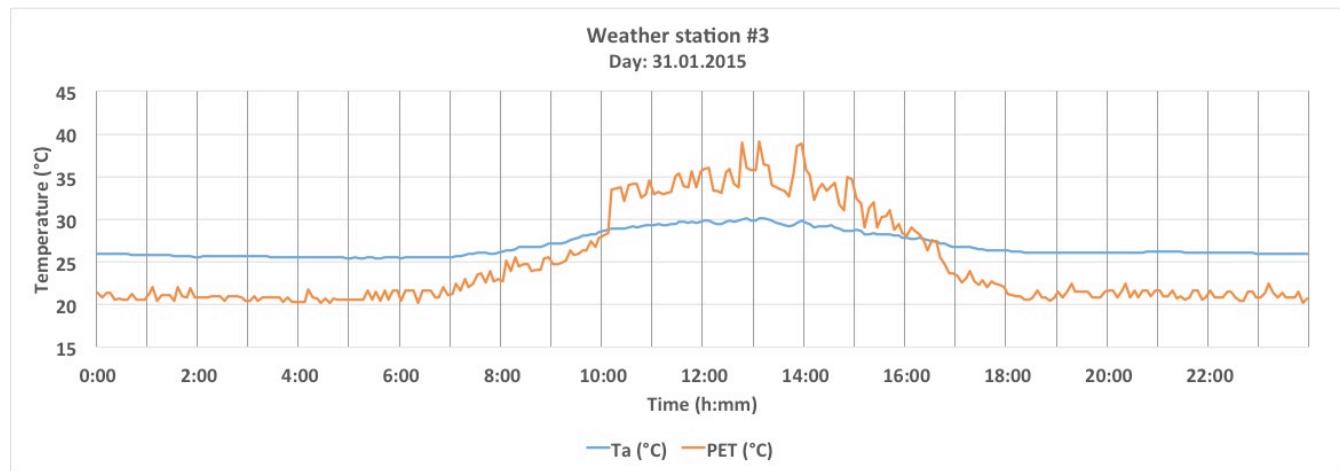
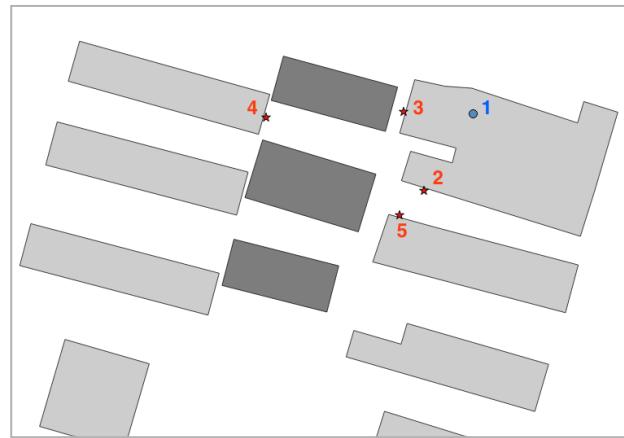
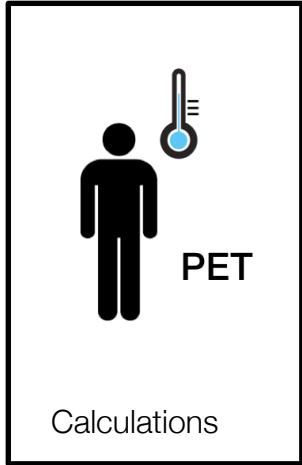
| Weather station | PET max. (°C) | PET min. (°C) | PET mean (°C) |
|-----------------|---------------|---------------|---------------|
| 2 | 55.1 | 18.3 | 27.1 |
| 3 | 54 | 17.6 | 26.6 |
| 4 | 50.7 | 18.5 | 25.2 |
| 5 | 51.8 | 18.2 | 24.6 |

January 2015

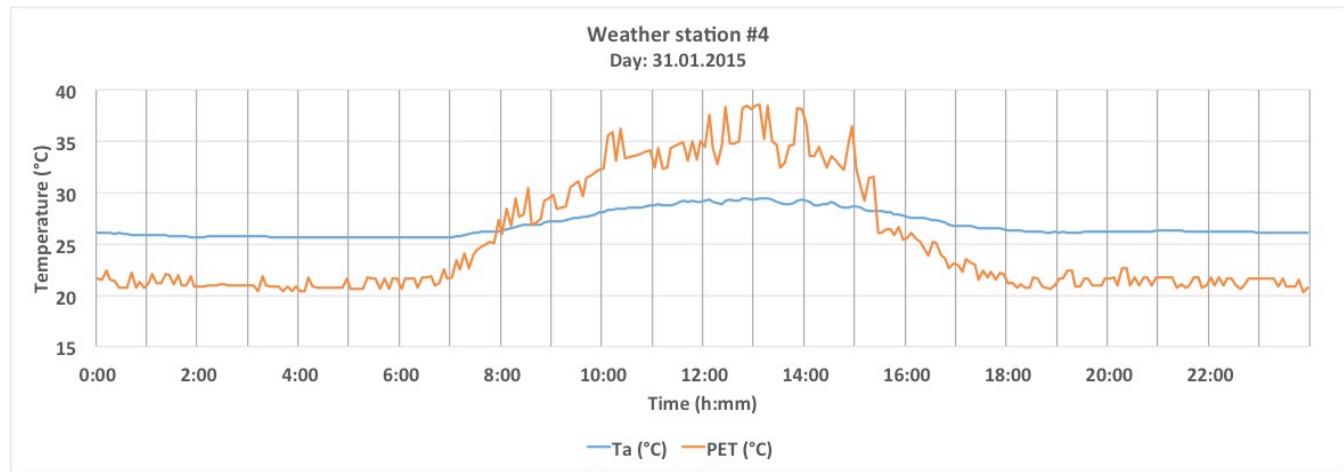
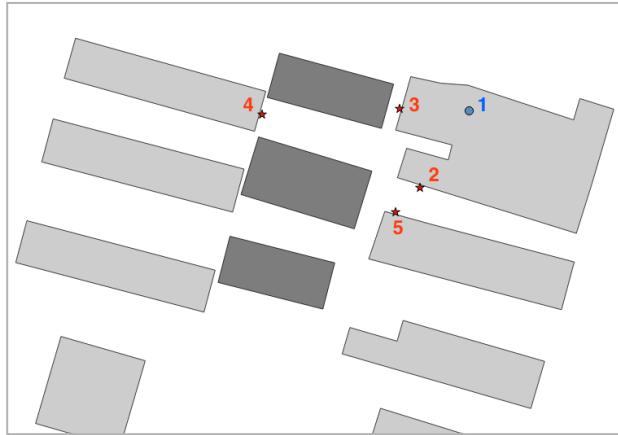
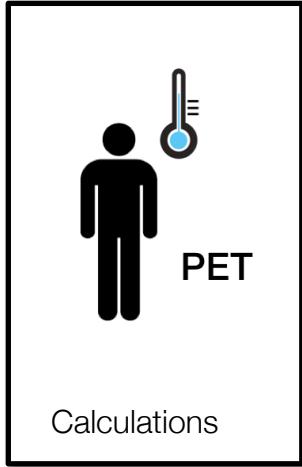
PET calculations



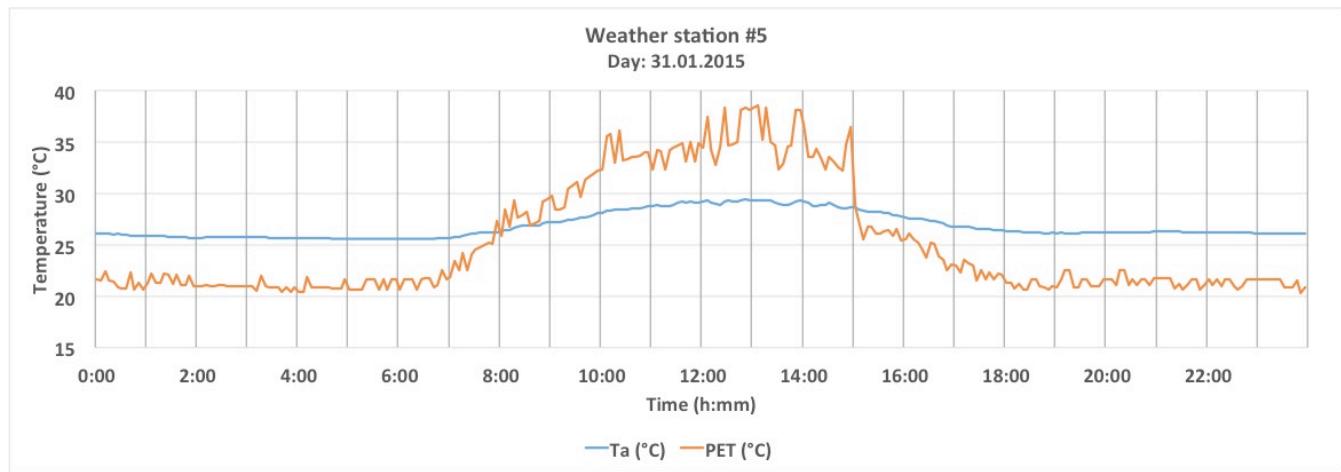
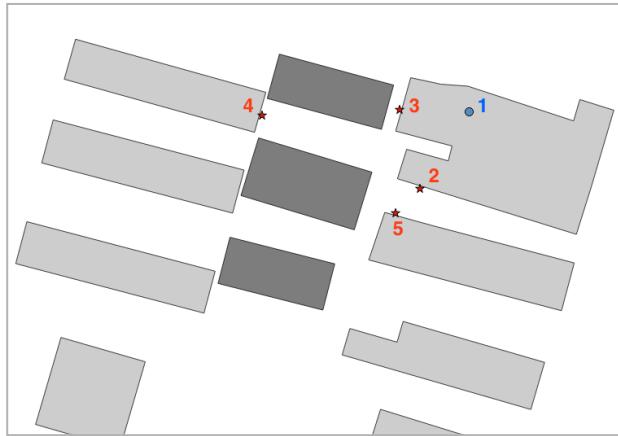
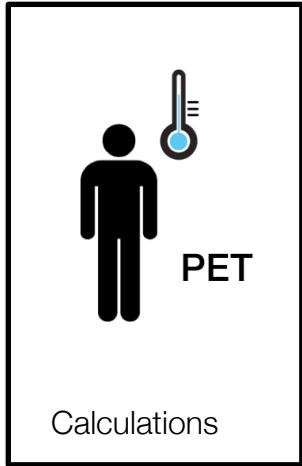
PET calculations



PET calculations



PET calculations



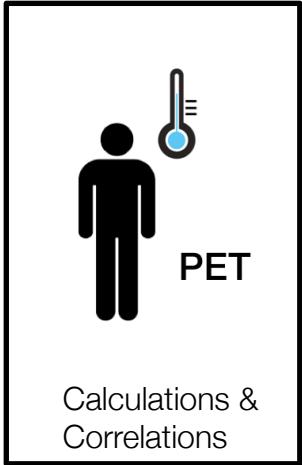
Conclusions

The wireless measurement network enables the **long distance monitoring** of the measurements of the weather stations.

The first set of results described in this paper show a first insight of what we could **predict**, such as the fact that the location of the weather station 2 is getting highest values of PET due to its exposure to the South.

It is necessary to develop the next set of results with the collection of a **long period of data recorded** in order to use reasonable amount of data for the final conclusions.

Next steps



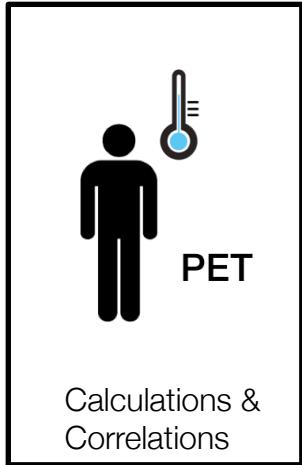
PET vs. Thermal sensation In situ Surveys

| Confort térmico en espacios exteriores en Barranquilla, Colombia: Correlación entre la respuesta humana de percepción térmica y los resultados del cálculo de índices de confort. | | | | | | Investigadores Participantes : Dr. Katia Villasego - CUC Msc. Estefanía Tapia - ETH |
|---|---|--|--|---|------------------------------------|--|
| 1. Datos de Control | | | | | | |
| Folio: | Fecha: | Hora Inicial | Hora Final | Emplazamiento | Sol | Sombra |
| Encuestador(a) | | | | <input type="checkbox"/> | <input type="checkbox"/> | |
| 2. Percepción del confort térmico | | | | | | |
| -3 | -2 | -1 | 0 | 1 | 2 | 3 |
| 2.1 Sensación Térmica <i>¿Qué siente usted en este momento con respecto a la temperatura?</i> | | | | | | |
| <input type="checkbox"/> Mucho frio | <input type="checkbox"/> Frio | <input type="checkbox"/> Un poco frio | <input type="checkbox"/> Ni frio/Ni calor | <input type="checkbox"/> Un poco de calor | <input type="checkbox"/> Calor | Mucho Calor |
| 2.2 Grado de Satisfacción <i>¿Cuál es su grado de satisfacción respecto a la temperatura en este momento?</i> | | | | | | |
| <input type="checkbox"/> Satisfecho | <input type="checkbox"/> Neutro | <input type="checkbox"/> Insatisfecho | | | | |
| 2.3 Preferencia Térmica <i>¿Que preferiría sentir en este momento con respecto a la temperatura?</i> | | | | | | |
| <input type="checkbox"/> Mas fresco | <input type="checkbox"/> Igual, sin cambios | <input type="checkbox"/> Mas Calor | | | | |
| 2.4 Percepción de la humedad <i>¿Qué siente usted en este momento con respecto a la humedad?</i> | | | | | | |
| <input type="checkbox"/> Muy húmedo | <input type="checkbox"/> Húmedo | <input type="checkbox"/> Un poco húmedo | <input type="checkbox"/> Normal | <input type="checkbox"/> Un poco seco | <input type="checkbox"/> Seco | Muy Seco |
| 2.5 Grado de Satisfacción <i>¿Cuál es su grado de satisfacción respecto a la humedad en este momento?</i> | | | | | | |
| <input type="checkbox"/> Satisfecho | <input type="checkbox"/> Neutro | <input type="checkbox"/> Insatisfecho | | | | |
| 2.6 Preferencia <i>¿Cómo preferiría sentir la humedad en este momento?</i> | | | | | | |
| <input type="checkbox"/> Más Húmedo | <input type="checkbox"/> Igual, sin cambios | <input type="checkbox"/> Más seco | | | | |
| 2.7 Percepción del viento <i>¿Cómo siente el viento en este momento?</i> | | | | | | |
| <input type="checkbox"/> Ningún Viento | <input type="checkbox"/> Poco viento | <input type="checkbox"/> Viento moderado | <input type="checkbox"/> Viento muy fuerte | | | |
| 2.8 Grado de Satisfacción <i>¿Cuál es su grado de satisfacción respecto al viento en este momento?</i> | | | | | | |
| <input type="checkbox"/> Satisfecho | <input type="checkbox"/> Neutro | <input type="checkbox"/> Insatisfecho | | | | |
| 2.9 Preferencia <i>¿Cómo preferiría sentir el viento en este momento?</i> | | | | | | |
| <input type="checkbox"/> Preferiría mas viento | <input type="checkbox"/> Igual en cambios | <input type="checkbox"/> Preferiría menos viento | | | | |
| 2.10 Percepción del asoleamiento <i>¿Cómo siente el sol en este momento?</i> | | | | | | |
| <input type="checkbox"/> Sin Sol | <input type="checkbox"/> Poco Sol | <input type="checkbox"/> con un poco de sol | <input type="checkbox"/> Sol muy fuerte | | | |
| 2.11 Grado de Satisfacción <i>¿Cuál es su grado de satisfacción respecto al sol en este momento?</i> | | | | | | |
| <input type="checkbox"/> Satisfecho | <input type="checkbox"/> Neutro | <input type="checkbox"/> Insatisfecho | | | | |
| 2.12 Preferencia sobre el tema <i>¿Cómo preferiría sentir el sol en este momento?</i> | | | | | | |
| <input type="checkbox"/> Preferiría mas sol | <input type="checkbox"/> Igual, sin cambios | <input type="checkbox"/> Preferiría menos sol | | | | |
| 2.13 Percepción del confort térmico <i>En general usted se siente con respecto al clima:</i> | | | | | | |
| <input type="checkbox"/> Confortable | <input type="checkbox"/> Inconfortable | | | | | |
| 3. Datos del Individuo | | | | | | |
| 3.1 Sexo | <input type="checkbox"/> Hombre | <input type="checkbox"/> Mujer | | | | |
| 3.2 Estatura (m): | 3.3 Peso (Kg): | | | 3.4 Edad: | | |
| 3.5 ¿Ha vivido siempre en Barranquilla? | <input type="checkbox"/> Si | | | <input type="checkbox"/> No | | |
| 3.6 Si NO, Con respecto a Barranquilla su lugar de procedencia es: | <input type="checkbox"/> Mas frio | <input type="checkbox"/> Igual | <input type="checkbox"/> Mas caliente | | | |
| 3.7 ¿Desde cuando está en Barranquilla? | <input type="checkbox"/> 1 semana | <input type="checkbox"/> > 1 mes | <input type="checkbox"/> 1 - 6 Meses | <input type="checkbox"/> > 6 Meses | | |
| 3.8 Con respecto a otros usted generalmente siente: | <input type="checkbox"/> Mas frio | <input type="checkbox"/> Igual | <input type="checkbox"/> Mas caliente | | | |
| 4. Datos por observación | | | | | | |
| 4.1 Vestimenta | Observación en caso de otro tipo de vestimenta: | | | | | |
| <input type="checkbox"/> Ligera ropa de verano | | | | | <input type="checkbox"/> Gorra | |
| <input type="checkbox"/> Cubierta ropa de invierno | | | | | <input type="checkbox"/> Sombrilla | |
| 4.2 Actividad | <input type="checkbox"/> Pasiva | <input type="checkbox"/> Moderada | <input type="checkbox"/> Intensa | | | |
| (En el momento) | (Sentado/de pie inmóvil) | (Marcha/de pie en movimiento) | (Trote/Marcha rápida) | | | |
| Observaciones: | | | | | | |

Location: UniNorte – stations

Next steps

PET vs. Thermal sensation Smartphone app

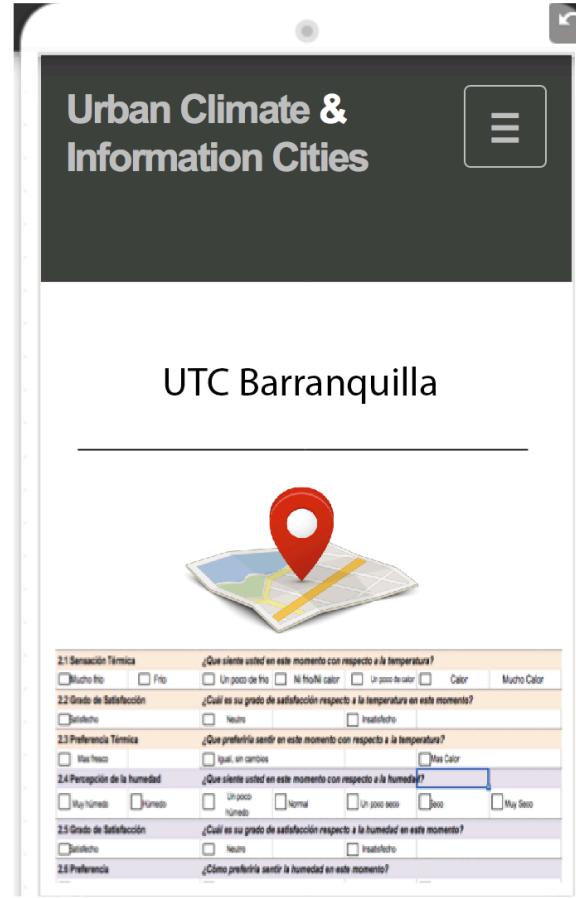
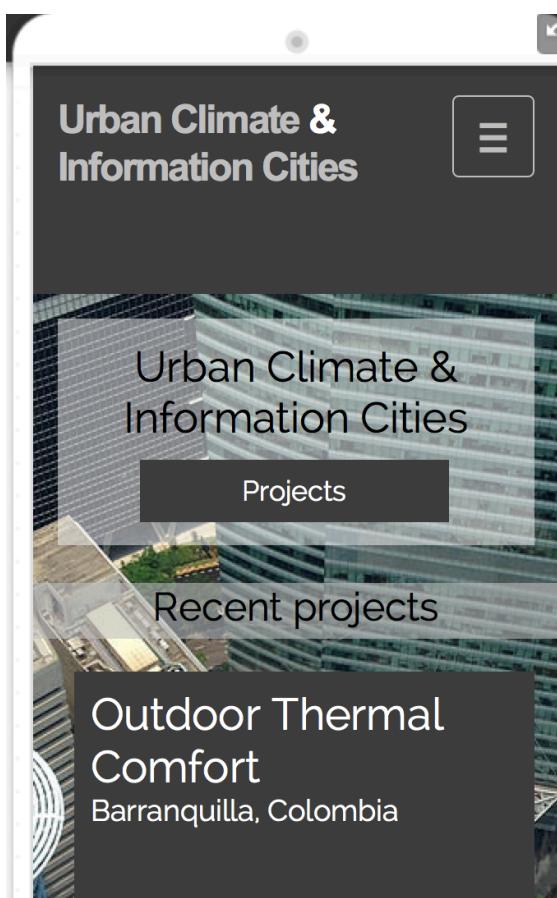
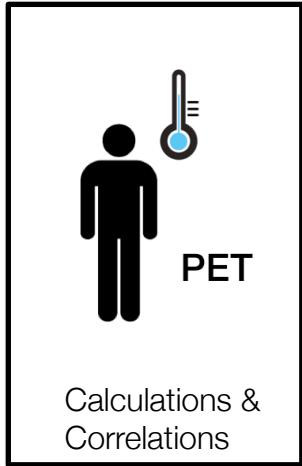


| Confort térmico en espacios exteriores en Barranquilla, Colombia: Correlación entre la respuesta humana de percepción térmica y los resultados del cálculo de índices de confort. | | Investigadores participantes : Dr. Kattia Villadiego - CUC Msc. Estefanía Tapias - ETH | | Confort térmico en espacios exteriores en Barranquilla, Colombia: Correlación entre la respuesta humana de percepción térmica y los resultados del cálculo de índices de confort. | | Investigadores participantes : Dr. Kattia Villadiego - CUC Msc. Estefanía Tapias - ETH | | | | | | | | | | | |
|---|-----------|---|------------------|---|--------|---|----------|--|--|--|--|---|--------------------------------|--------------------------------------|--|--|--|
| Datos de Control identificados por la aplicación automáticamente | | | | Percepción del confort térmico | | | | | | | | | | | | | |
| 1. Id encuesta o código de usuario | 2. Fecha: | 3. Hora | 4. Emplazamiento | Sol | Sombra | Exterior | interior | -3 | -2 | -1 | 0 | 1 | 2 | 3 | | | |
| | | | | | | | | 2.1 Sensación Térmica | ¿Que siente usted en este momento con respecto a la temperatura? | | | | | | | | |
| | | | | | | | | <input type="checkbox"/> Mucho frio | <input type="checkbox"/> Frio | <input type="checkbox"/> Un poco de frio | <input type="checkbox"/> Ni frio/N calor | <input type="checkbox"/> Un poco de calor | <input type="checkbox"/> Calor | <input type="checkbox"/> Mucho Calor | | | |
| | | | | | | | | 2.2 Grado de Satisfacción | ¿Cuál es su grado de satisfacción respecto a la temperatura en este momento? | | | | | | | | |
| | | | | | | | | <input type="checkbox"/> Satisfecho | <input type="checkbox"/> Neutro | <input type="checkbox"/> Insatisfecho | | | | | | | |
| | | | | | | | | 2.3 Preferencia Térmica | ¿Que preferiría sentir en este momento con respecto a la temperatura? | | | | | | | | |
| | | | | | | | | <input type="checkbox"/> Mas fresco | <input type="checkbox"/> Igual, sin cambios | <input type="checkbox"/> Mas Calor | | | | | | | |
| | | | | | | | | 2.4 Percepción de la humedad | ¿Que siente usted en este momento con respecto a la humedad? | | | | | | | | |
| | | | | | | | | <input type="checkbox"/> Muy húmedo | <input type="checkbox"/> Húmedo | <input type="checkbox"/> Un poco húmedo | <input type="checkbox"/> Normal | <input type="checkbox"/> Un poco seco | <input type="checkbox"/> Seco | <input type="checkbox"/> Muy Seco | | | |
| | | | | | | | | 2.5 Grado de Satisfacción | ¿Cuál es su grado de satisfacción respecto a la humedad en este momento? | | | | | | | | |
| | | | | | | | | <input type="checkbox"/> Satisfecho | <input type="checkbox"/> Neutro | <input type="checkbox"/> Insatisfecho | | | | | | | |
| | | | | | | | | 2.6 Preferencia | ¿Cómo preferiría sentir la humedad en este momento? | | | | | | | | |
| | | | | | | | | <input type="checkbox"/> Mas Húmedo | <input type="checkbox"/> Igual, sin cambios | <input type="checkbox"/> Más seco | | | | | | | |
| | | | | | | | | 2.7 Percepción del viento | ¿Cómo siente el viento en este momento? | | | | | | | | |
| | | | | | | | | <input type="checkbox"/> Ningún Viento | <input type="checkbox"/> Poco viento | <input type="checkbox"/> Viento moderado | <input type="checkbox"/> Viento muy fuerte | | | | | | |
| | | | | | | | | 2.8 Grado de Satisfacción | ¿Cuál es su grado de satisfacción respecto al viento en este momento? | | | | | | | | |
| | | | | | | | | <input type="checkbox"/> Satisfecho | <input type="checkbox"/> Neutro | <input type="checkbox"/> Insatisfecho | | | | | | | |
| | | | | | | | | 2.9 Preferencia | ¿Cómo preferiría sentir el viento en este momento? | | | | | | | | |
| | | | | | | | | <input type="checkbox"/> Preferiría mas viento | <input type="checkbox"/> Igual sin cambios | <input type="checkbox"/> Preferiría menos viento | | | | | | | |
| | | | | | | | | 2.10 Percepción del sol | ¿Cómo siente el sol en este momento? | | | | | | | | |
| | | | | | | | | <input type="checkbox"/> Sin Sol | <input type="checkbox"/> Poco Sol | <input type="checkbox"/> Sólo un poco tuerne | <input type="checkbox"/> Sol muy fuerte | | | | | | |
| | | | | | | | | 2.11 Grado de Satisfacción | ¿Cuál es su grado de satisfacción respecto al sol en este momento? | | | | | | | | |
| | | | | | | | | <input type="checkbox"/> Satisfecho | <input type="checkbox"/> Neutro | <input type="checkbox"/> Insatisfecho | | | | | | | |
| | | | | | | | | 2.12 Preferencia sobre el tema | ¿Cómo preferiría sentir el sol en este momento? | | | | | | | | |
| | | | | | | | | <input type="checkbox"/> Preferiría mas sol | <input type="checkbox"/> Igual, sin cambios | <input type="checkbox"/> Preferiría menos sol | | | | | | | |
| | | | | | | | | 2.13 Percepción del confort térmico | En general usted se siente con respecto al clima: | | | | | | | | |
| | | | | | | | | <input type="checkbox"/> Confortable | <input type="checkbox"/> Inconfortable | | | | | | | | |

Location: City – Students

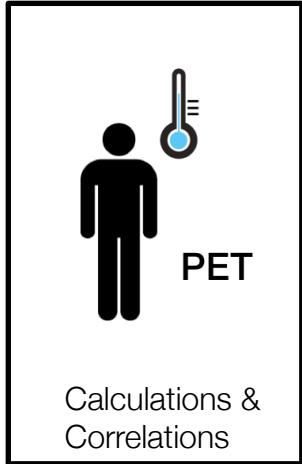
Next steps

PET vs. Thermal sensation Smartphone app



Next steps

PET vs. Thermal sensation Smartphone app

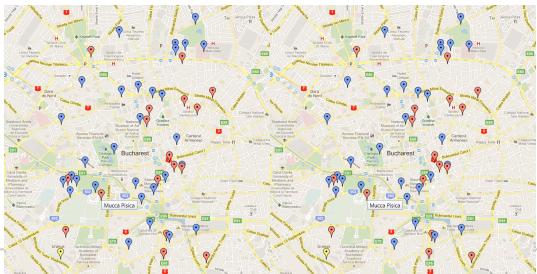


Urban Climate & Information Cities

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OUTDOOR THERMAL COMFORT (OTC)

The research project is based on my doctoral research thesis at the [Chair of Information Architecture, ETH Zurich](#). It is conducted in the city of Barranquilla in Colombia, using the campus of the [Universidad del Norte](#) as case study area.



Barranquilla, Colombia
Thu Jul. 23, 2015

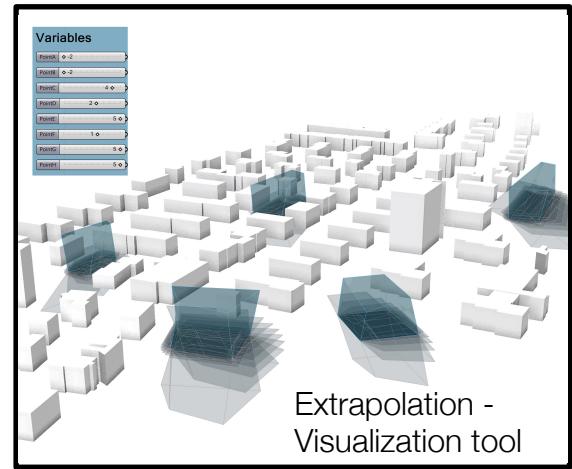
 **26°C**
Chance of a Thunderstorm

Wind: NNW 9mph
Humidity: 74%
Visibility: 0 miles

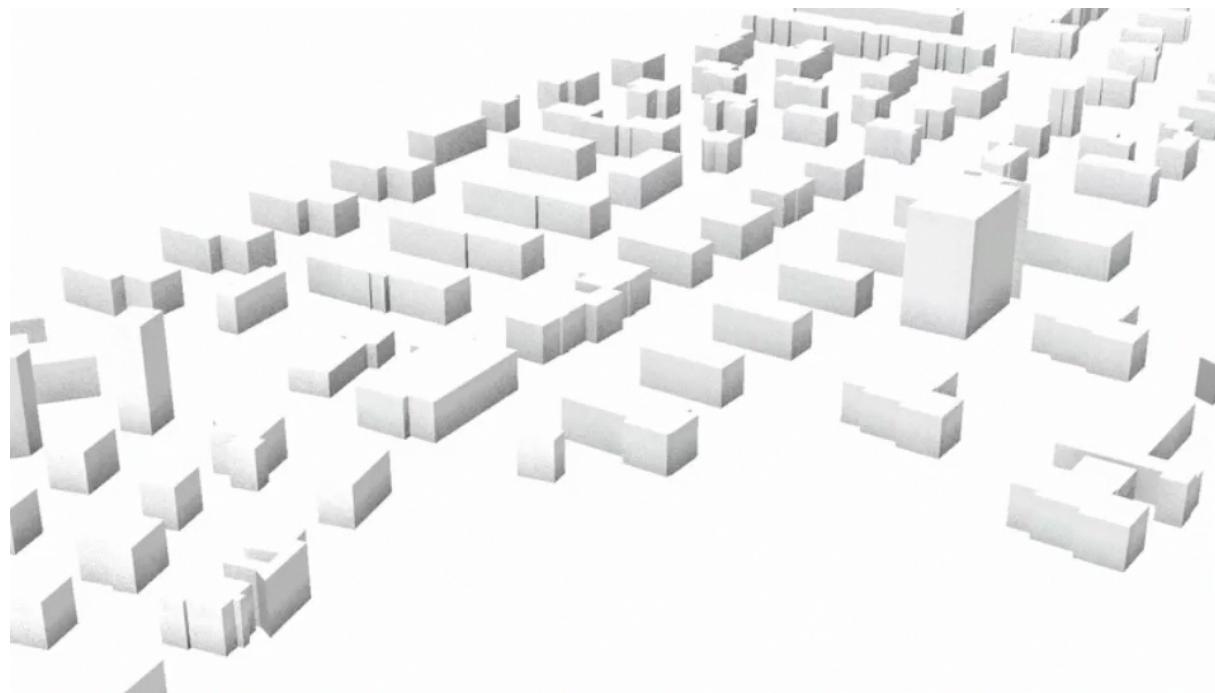
Next steps



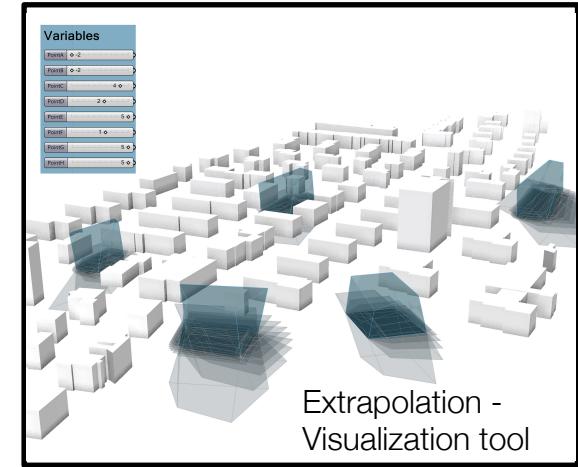
Parameterized design-feedback tool



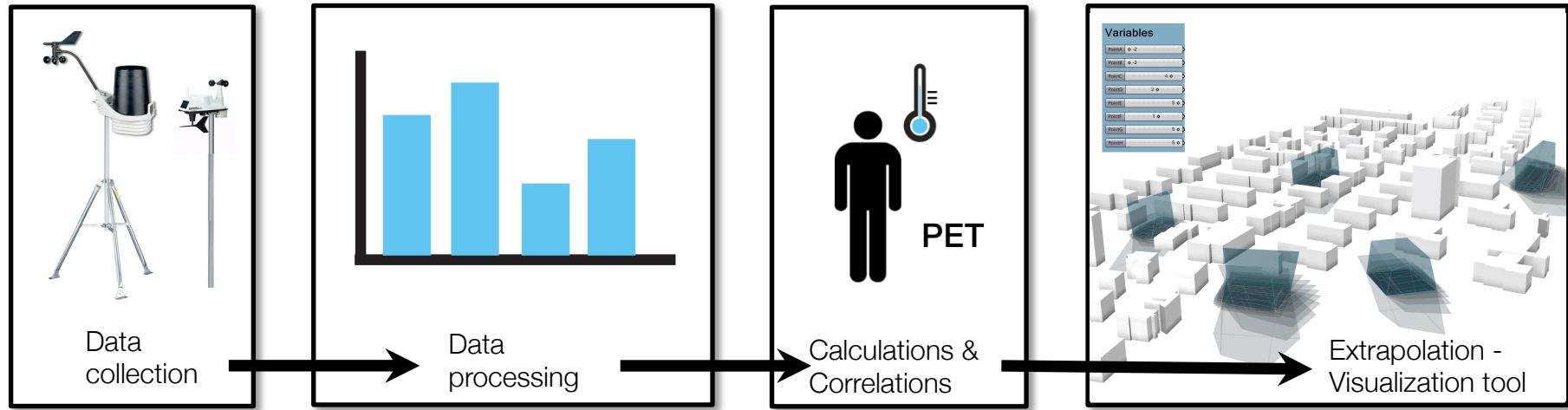
Next steps



Tapias, E., 2013



Context – overall research



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