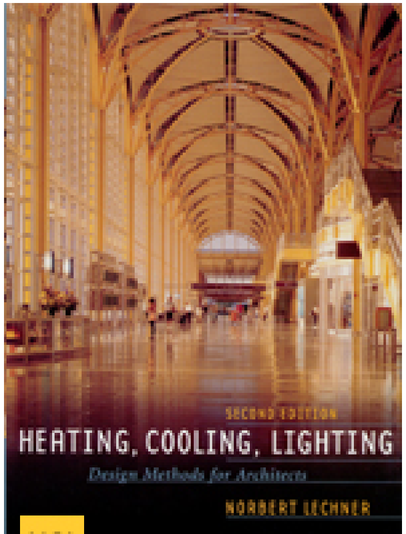
Arch 125: Intro to Environmental Design
Environmental Site Design

Winter 2010



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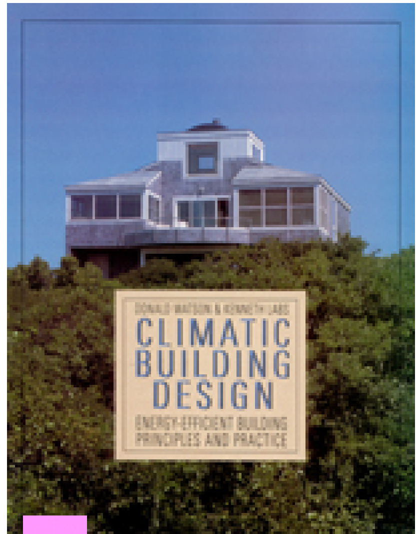

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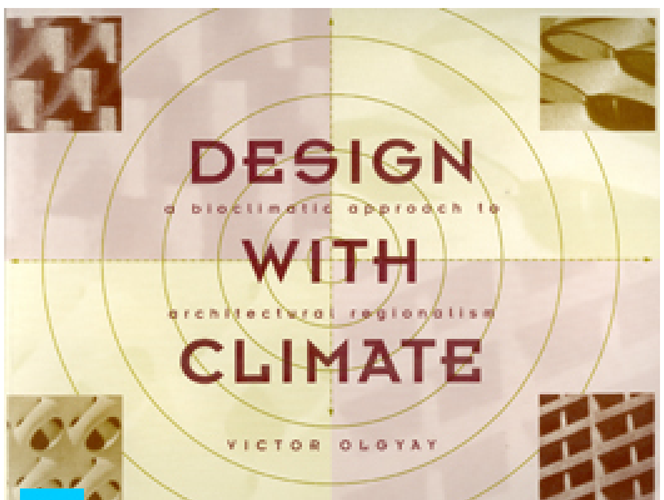

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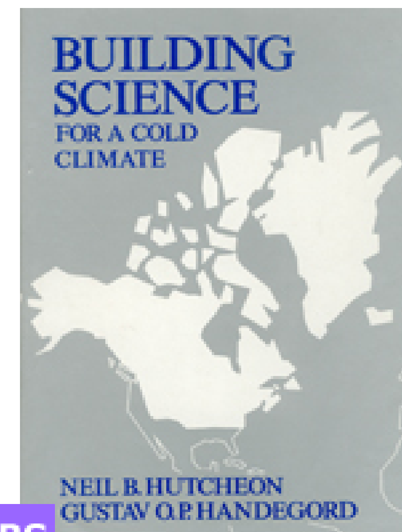


BS

Texts used in the preparation of this presentation.

What is Environmental Site Design?

Environmentally sensitive design looks to design in harmony with, and in response to the climate. It attempts to use the natural solar and ventilation characteristics of the local climate/environment to inform the building design so to minimize use and dependency on consumptive non renewable energy sources. Sustainable building design looks to "live lightly on the earth" so that there will be quality and resources remaining for generations to come.

Designing an environmentally responsible site asks for a **specific response to the local/regional climate characteristics**.

“My prescription for a modern house: first a good site. Pick one that has features making for character… then build your house so that you may still look from where you stood upon all that charmed you, and lose nothing of what you saw before the house was built, but see more.”

-- Frank Lloyd Wright

Do you think the house pictured here actually answers this suggestion??

Falling Water, Frank Lloyd Wright

#1 - Climate Zones

Bio-Regional Site Characteristics:

Meaning:

first understand whether your building is located in a

COLD

TEMPERATE

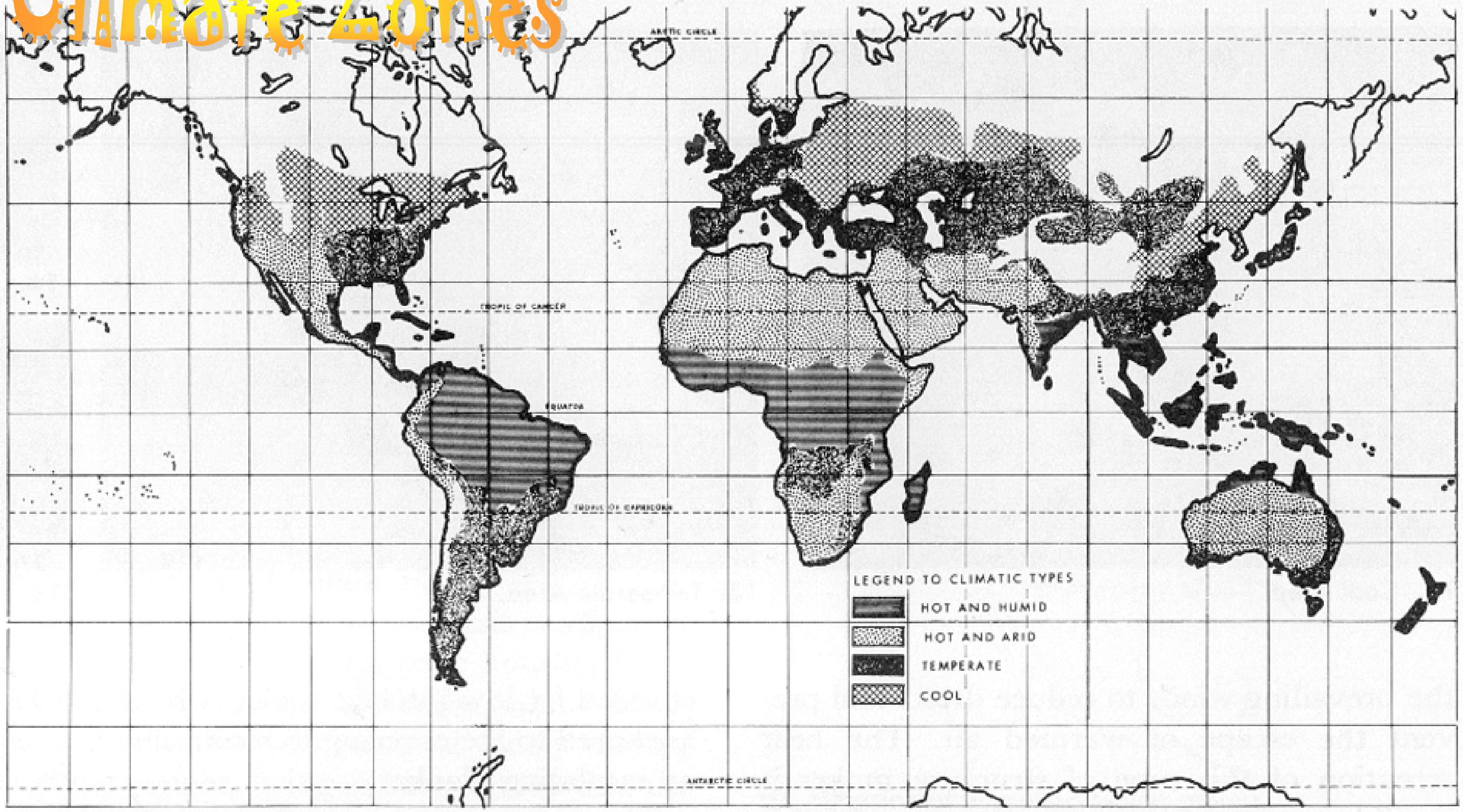
HOT-ARID

HOT-HUMID

climate zone???

It makes a HUGE difference….

Climate Zones

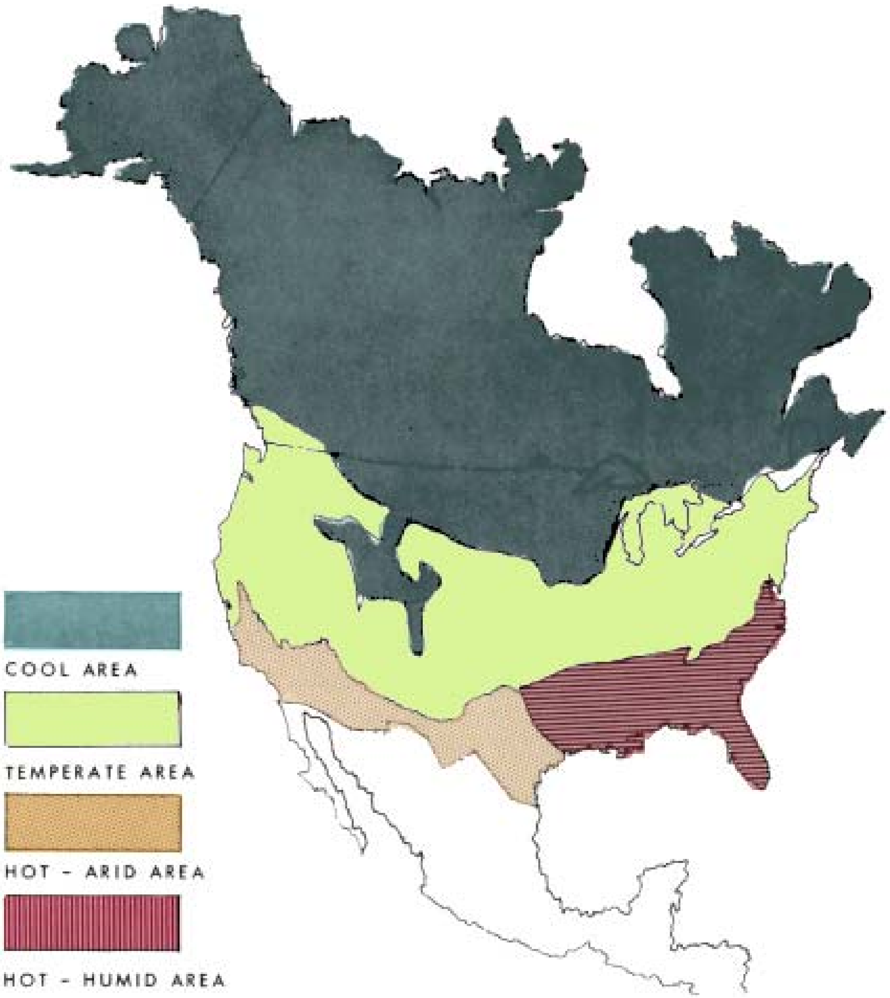


16. Climatic zones.

From "Design with Climate", Olgyay, 1963

DWC

Climate Zones



11. Regional climate zones of the North American continent.

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Climate Zones

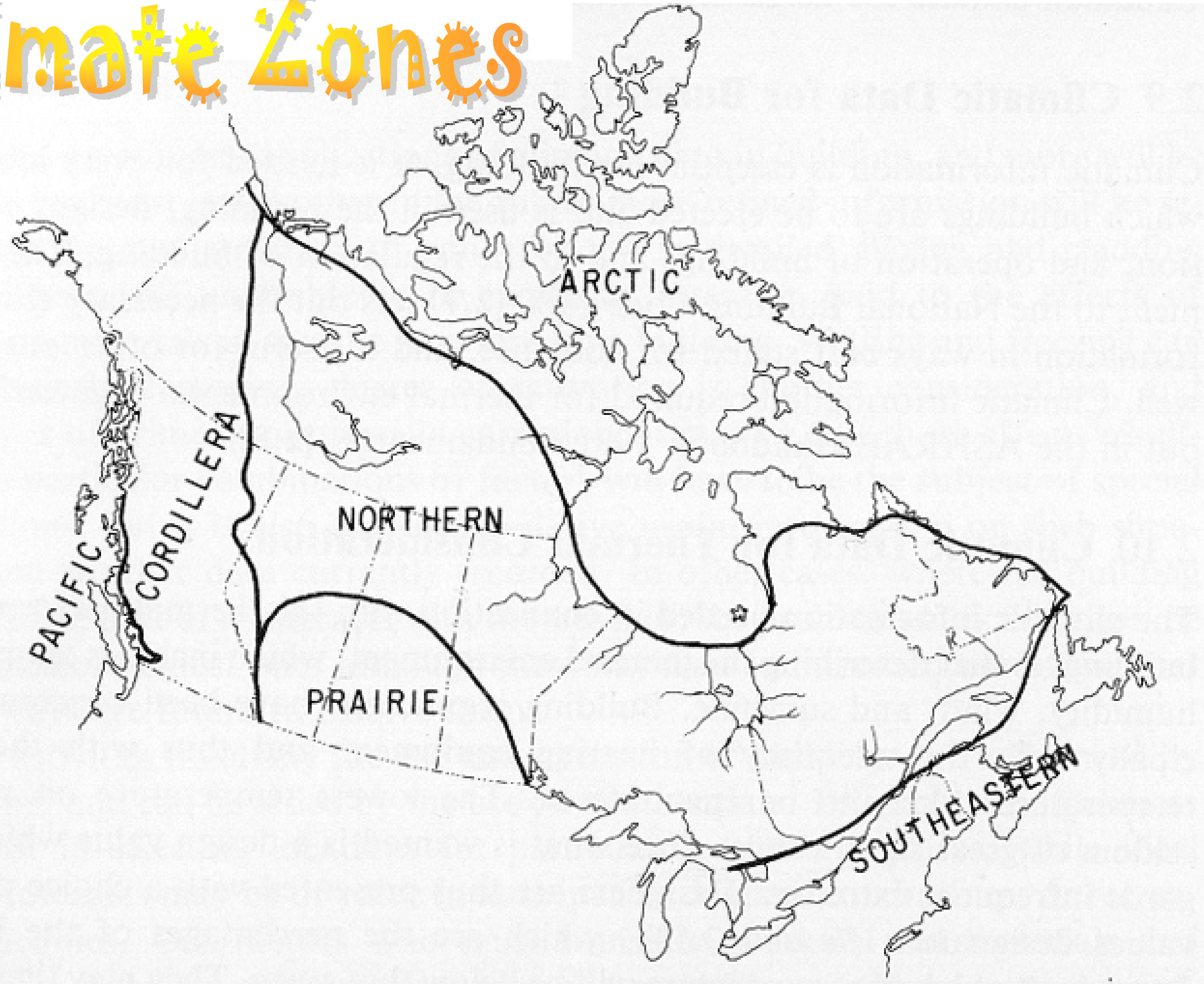


FIGURE 2.5 Climate regions of Canada. (*The climate of Canada*, Meteorological Branch, Department of Transport, 1962, Fig. 4)[**2.5**]

Canadian climate zones must be further broken down to respond to local conditions, degree-days and humidity (rain and snow).

#2 - Keyword: Microclimate

When we design WITH the specific local environmental characteristics in mind, we start to manipulate the relationship between the climate, the site and the building to create a local environment or MICROCLIMATE around the building.

This "mini climate" that is created around the building can *decrease the apparent severity* of the climate (and hence the work the building must do to make for a comfortable interior AND exterior environment around the building) OR, if badly handled, can *increase the severity of the local climate*.

#3 - Site Bio-Configuration

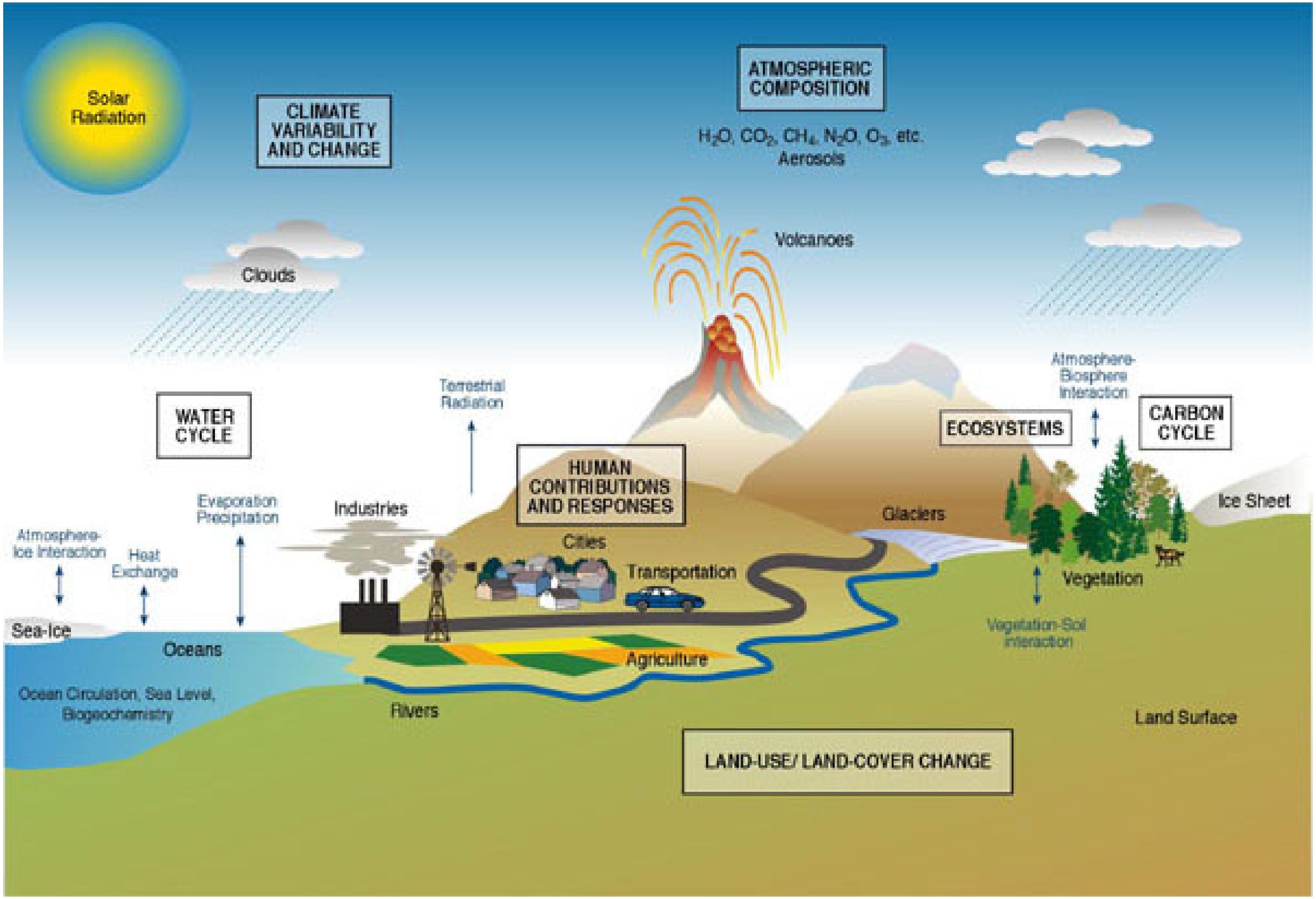
Whatever the FOUND condition of the site upon which we are to consider building has a climate that is not only dependent upon the general climate of the REGION, but also, the specific climate of the site as affected by:

- the surface or surfaces that cover the ground
- available tree cover, size, height, biodiversity, species, etc.
- nearness to water
- amount of paving adjacent
- height of adjacent buildings

The Multivariate Condition

PEOPLE	BUILDING	SITE	CLIMATE
interior conditions ♦ temperature ♦ radiant temperatures ♦ air motion ♦ humidity metabolism clothing activity perception acclimatization	modes ♦ mechanical cooling ♦ mechanical temperi ♦ passive cooling ♦ equilibrium ♦ passive heating ♦ mechanical heating loads ♦ envelope conduction convection radiation infiltration solar gain ♦ internal people lights equipment ventilation	topography orientation bodies of water surrounding structures vegetation clustering elongation	elements: ♦ sun ♦ cloudiness ♦ wind ♦ temperature ♦ humidity ♦ precipitation seasons diurnal variation variability **character:** ♦ **temperate** ♦ **hot arid** ♦ **hot humid** ♦ **cold** factors: ♦ latitude ♦ longitude ♦ altitude ♦ continentality ♦ coastal
GIVEN OR RESULT	ARCHITECTURE AS MEDIATION	ARCHITECTURE AS MEDIATION	GIVEN OR RESULT

As cities and roads replace natural landscape, the climate of the region is altered.


Solar Radiation
CLIMATE VARIABILITY AND CHANGE
ATMOSPHERIC COMPOSITION
H_2O, CO_2, CH_4, N_2O, O_3, etc.
Aerosols
Clouds
Volcanoes
Terrestrial Radiation
Atmosphere-Biosphere Interaction
WATER CYCLE
ECOSYSTEMS
CARBON CYCLE
HUMAN CONTRIBUTIONS AND RESPONSES
Evaporation Precipitation
Industries
Glaciers
Ice Sheet
Atmosphere-Ice Interaction
Heat Exchange
Cities
Transportation
Vegetation
Sea-Ice
Oceans
Vegetation-Soil Interaction
Agriculture
Ocean Circulation, Sea Level, Biogeochemistry
Rivers
Land Surface
LAND-USE/ LAND-COVER CHANGE

Energy Balances and Microclimate Impacts

The replacement of croplands, forests, and open grassy fields with roads, buildings, and other impervious surfaces and structures changes the relationship between incoming solar radiation and outgoing terrestrial radiation within watershed areas. The conversion of pervious surfaces to impervious surfaces alters local energy balances through changes in:

* the albedos of surfaces,
* the specific heat capacities and thermal conductivities of surfaces,
* the ratio of sensible heat to latent heat flowing from the surface into the atmosphere

Albedo - ***The percentage of incoming solar radiation reflected by a surface.*** This reflected energy is unavailable for sensible and latent heating, therefore the albedos of watershed surfaces determines their relative rates of heating. Urbanization decreases the overall albedo of watershed surfaces by approximately 10%.

Sensible Heat - ***Heat energy which is felt and can be measured with a thermometer.*** Heat energy not utilized in evapotranspiration is released to the atmosphere as sensible heat. The more energy that enters the atmosphere as sensible heat, the higher the relative air temperatures over watershed surfaces.

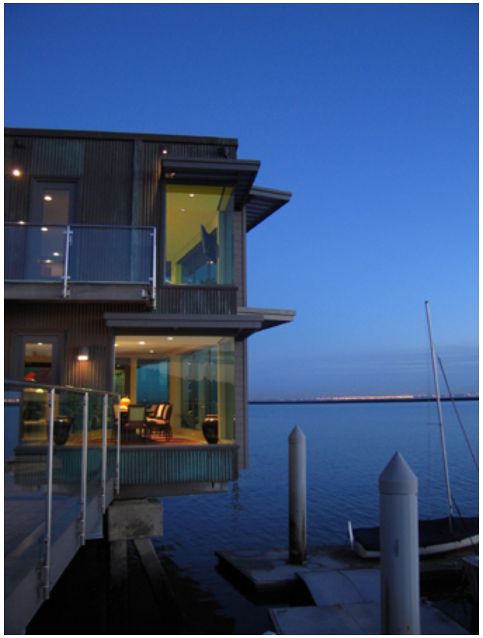
Latent Heat - ***Heat energy stored in water vapor; it cannot be felt or measured with a thermometer.*** It is not available for sensible heating. Latent heat enters the atmosphere when water is evaporated from the surface. Since evaporation removes heat , it is a cooling process.

This does not belong here...

Basic understanding of the 4 climate design zones tells us that certain building types obviously do not belong in certain places...

…but there are more aspects to consider...

Each of these houses,by their climate and siting, feels different to live in.

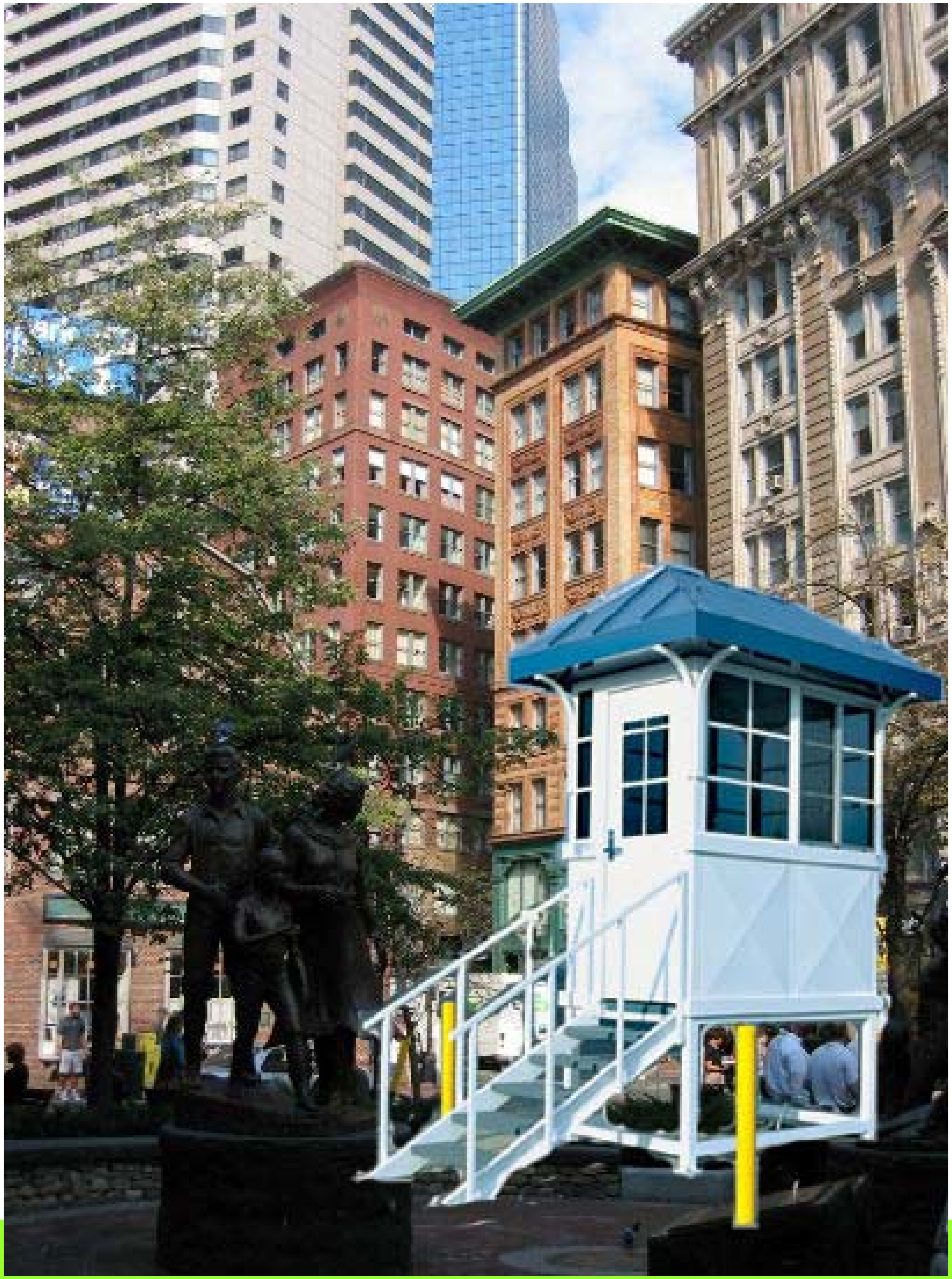


Take even the best house and place it in the middle of an asphalt parking lot, and see what happens...

The Story of the Wandering Booth…

This is a parking attendant's booth that I found on the internet. Let's move it around and see what happens….


www.ECOresearch.net

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www.tibetsupport.org


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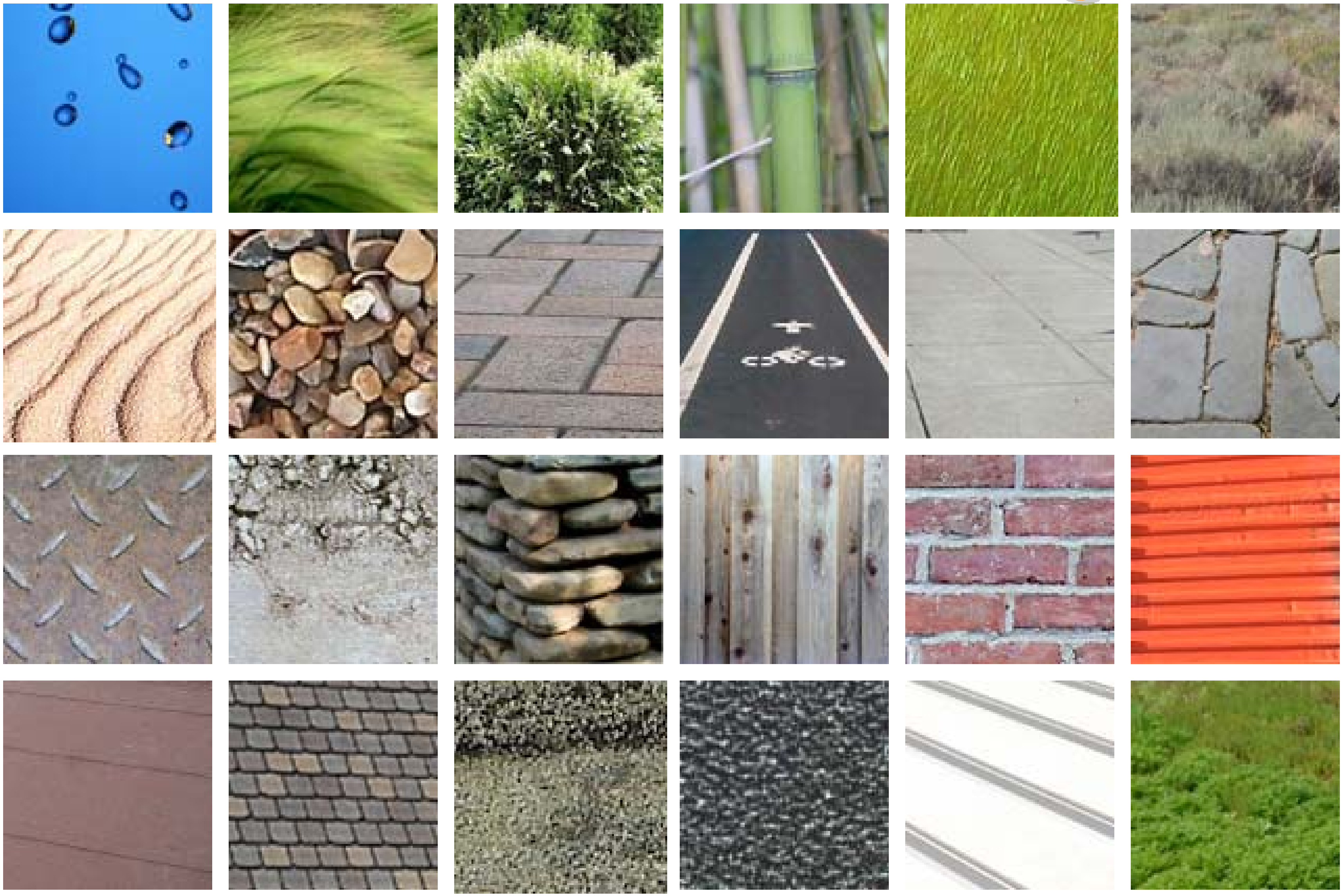
#4 - Site Materiality



found site

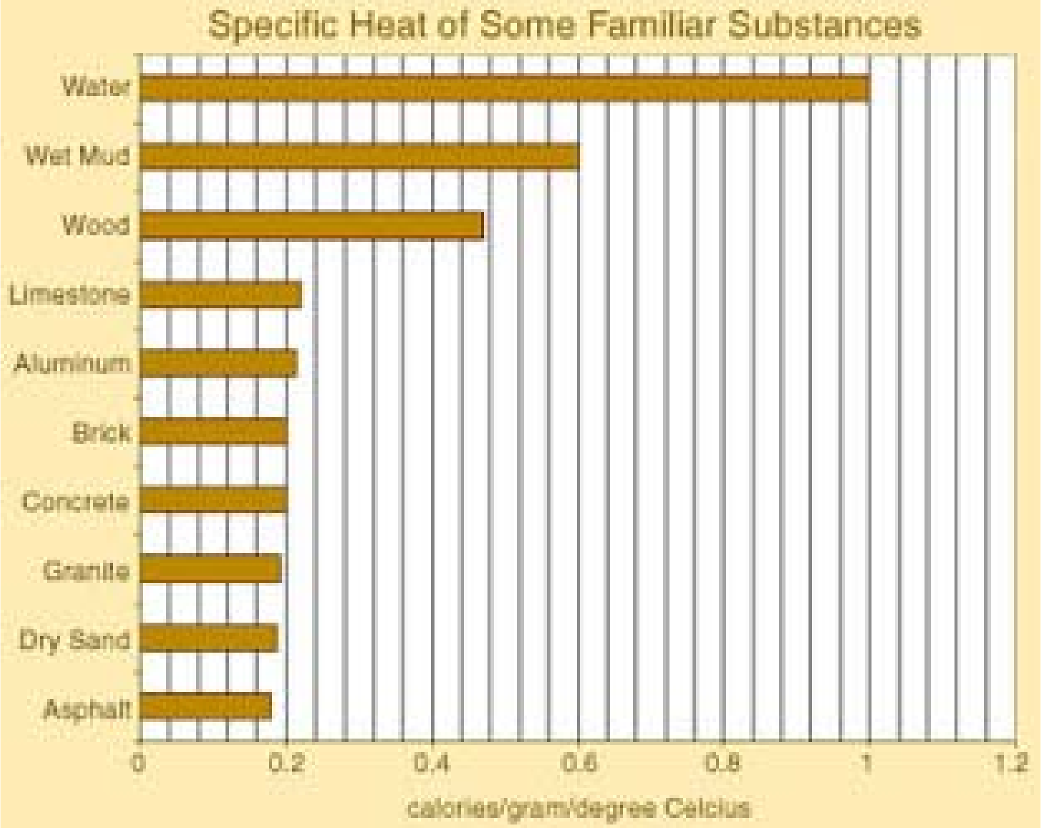
horizontal

walls

roofs

Specific Heat of Materials

Surface materials respond differently when exposed to the same amounts of solar radiation. Some heat rapidly whereas others heat slowly. This property is called specific heat capacity.



Specific heat is the amount of energy required to raise the temperature of one gram of a substance 1 ° C. For example, it takes five times more energy to raise the temperature of water than it does to raise the temperature of concrete; therefore water has the higher specific heat capacity.

Heat Storage Capacity of Materials

The specific heat of materials is different than their ability to store this heat. This is referred to as their "thermal mass" or "heat storage capacity".

We often make a choice, depending on the climate, if we need to store heat to have it released later in the day, when the sun is down and things have "cooled off". *We see this in hot-arid buildings.*

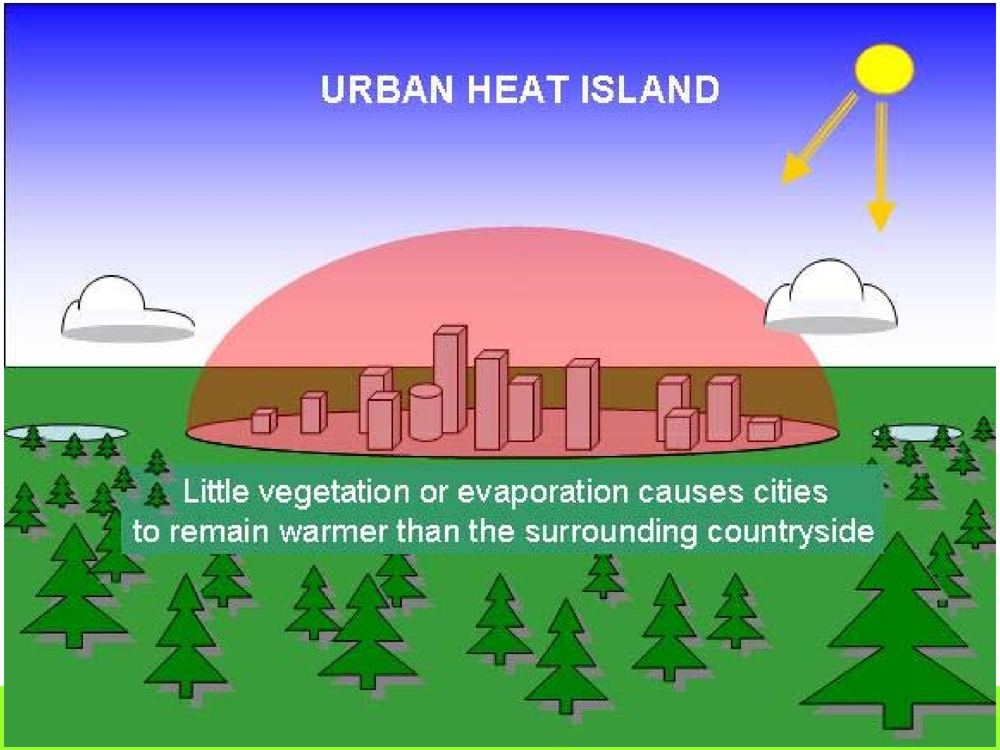
Heat Storage Capacity of Common Materials

MATERIAL	Heat Storage Capacity BTU/Cubic ft./°F
Water	62.5
Cast Iron	54.0
Concrete	31.7
Glass	27.7
Oak	26.8
Brick	24.8
Earth	20.0
Gypsum	20.3
Pine	18.1
Air	0.018

Urban Heat Island Effect

"Urban Heat Island" (UHI) refers to the tendency for a city to remain warmer than its surroundings. This effect is caused mostly by the lack of vegetation and soil moisture, which would normally use much of the absorbed sunlight to evaporate water as part of photosynthesis (a process called "evapotranspiration"). Instead, the sunlight is absorbed by manmade structures: roads, parking lots, and buildings.

With little or no water to evaporate, the sunlight's energy goes into raising the temperature of those surfaces. After the sun sets, the city is so warm that it never cools down as much as the countryside around it, and so retains the heat island effect all night long.



Urban Heat Island

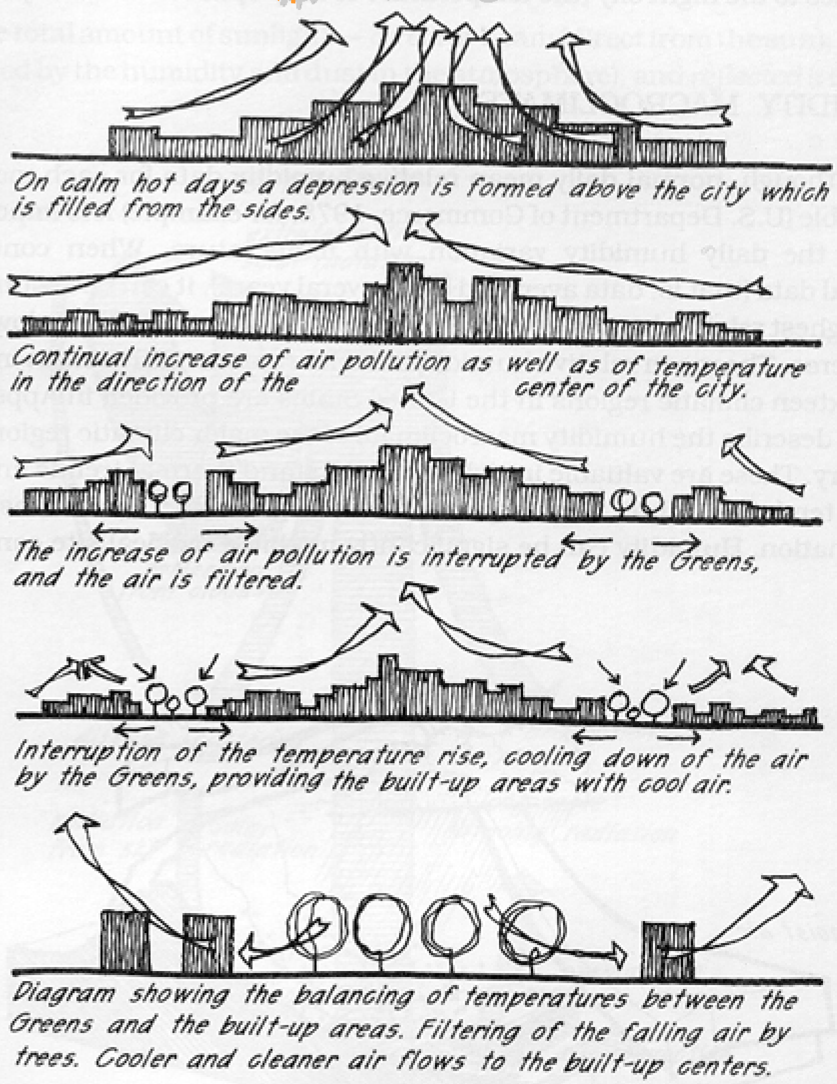
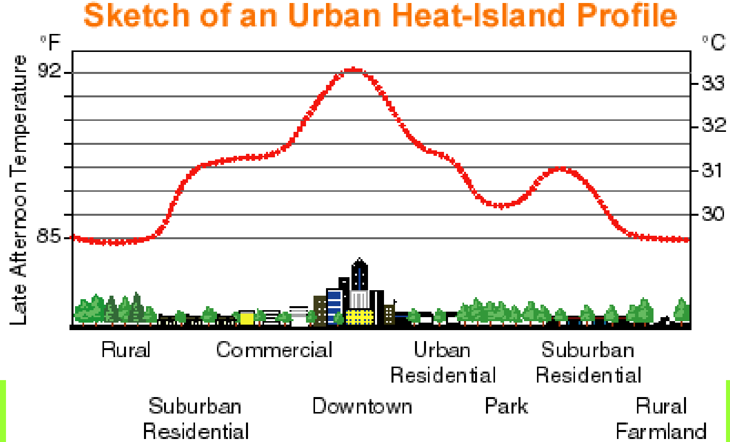


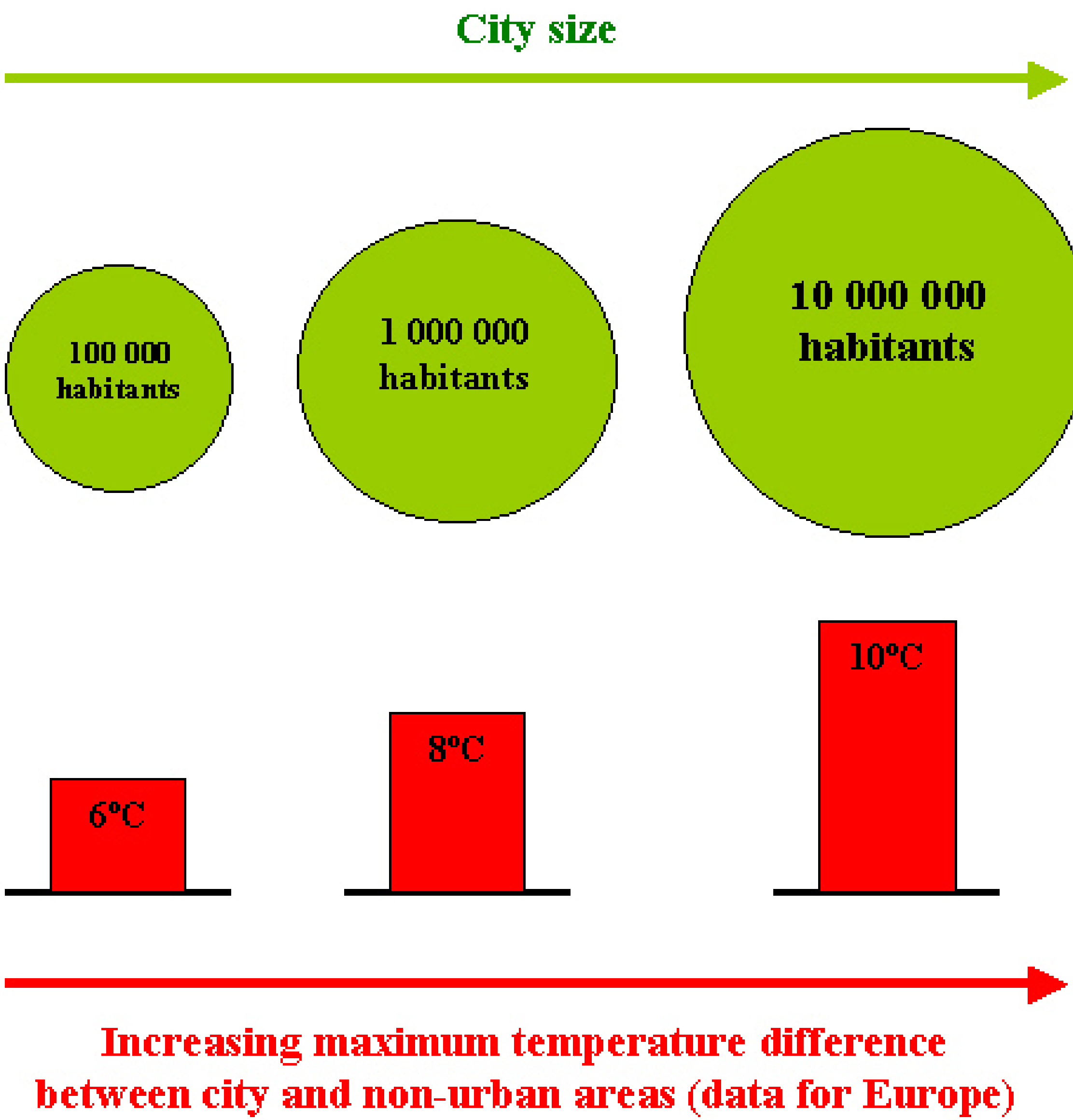
Figure 4.3: Convective air circulation due to "urban heat island" effect and the mitigation of this effect through the use of parks and greenspaces. *(Redrawn from Robinette, 1977, by permission.)*

HCL

Whether you are sited in a city or suburban space makes a difference. Access to green space can keep the building cool. The "urban heat island effect" is caused by too much building, hot roofs, pavement, *(aka thermal mass)* and not enough greenery in cities. Tree cover is also important to keep the sun off of paved areas.

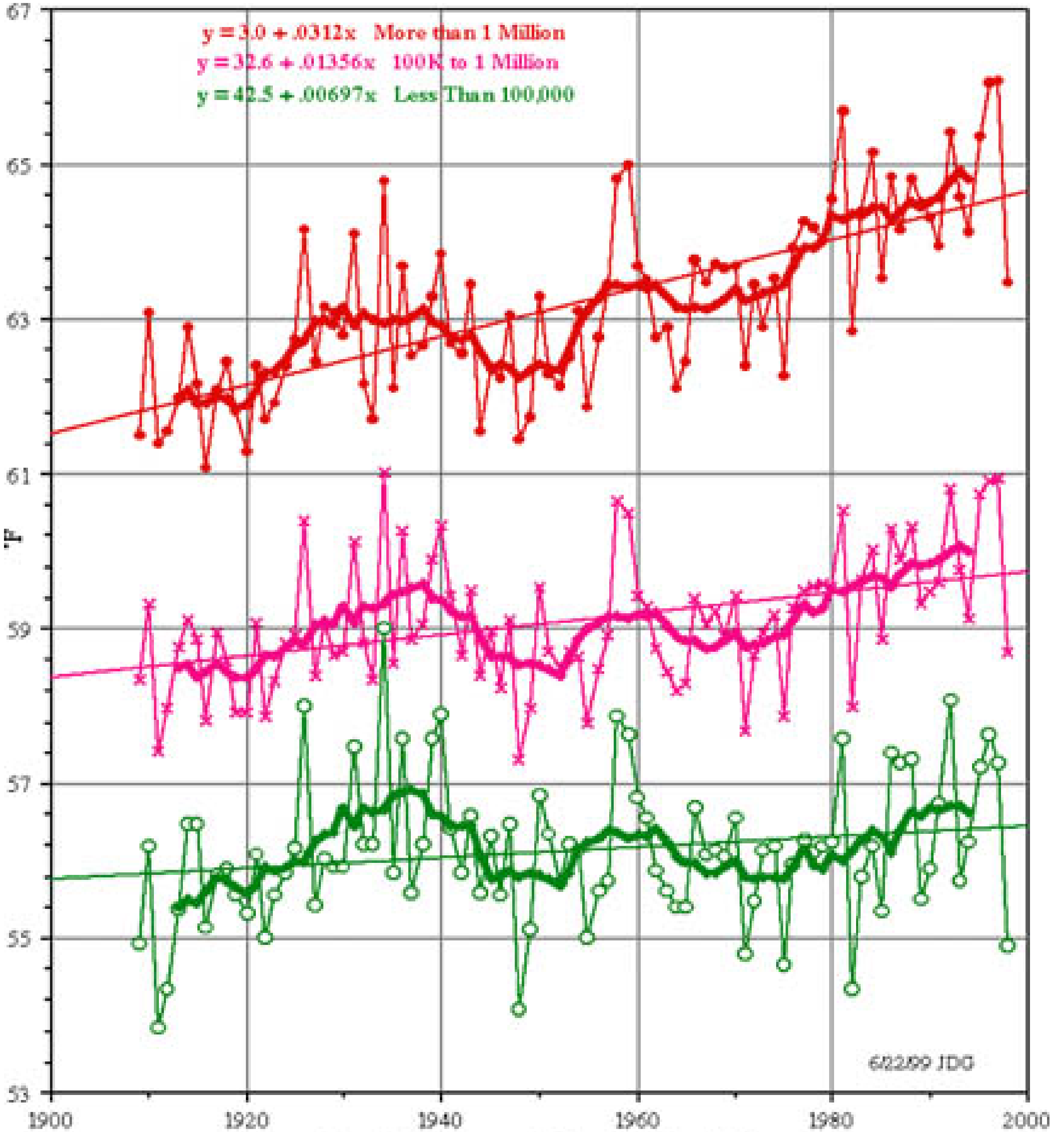


Even a park the size of Central Park in NY cannot provide enough cooling for a city of this size, but it helps.



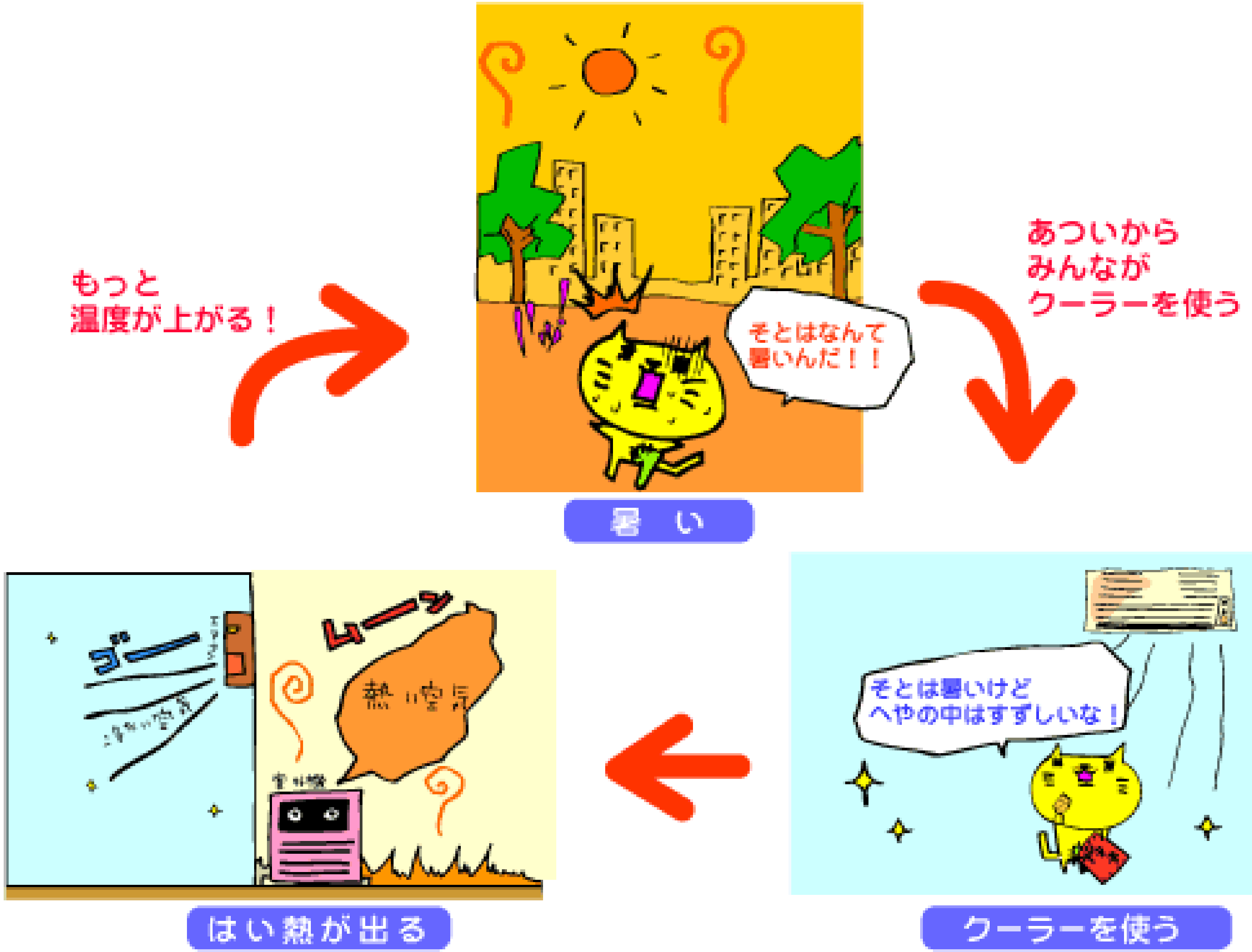
City size also impacts the overall temperature differential between urban and adjacent non urban areas.

California Temperature Trend by County Population

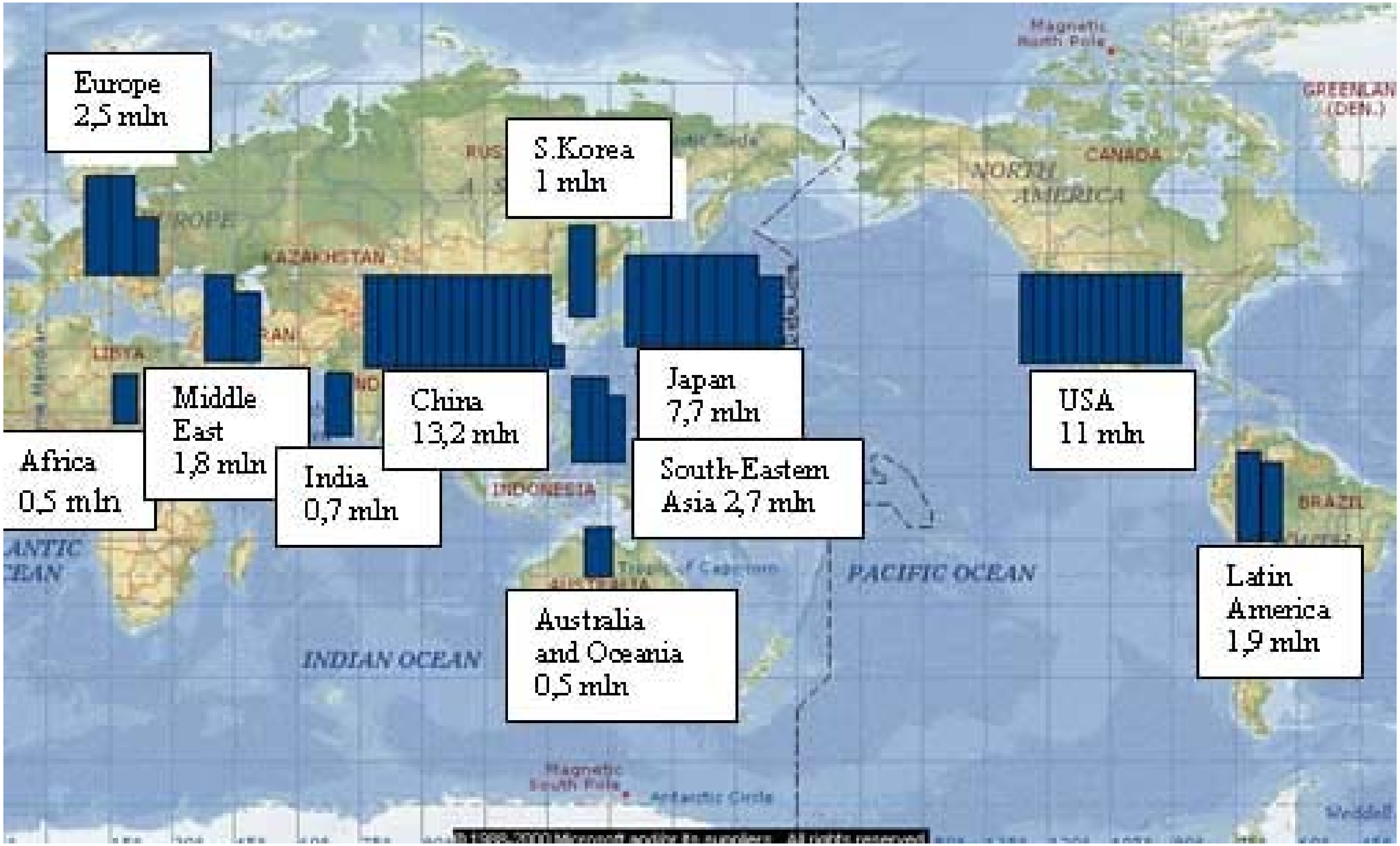


Based on 94 records from 1909 to 1998.

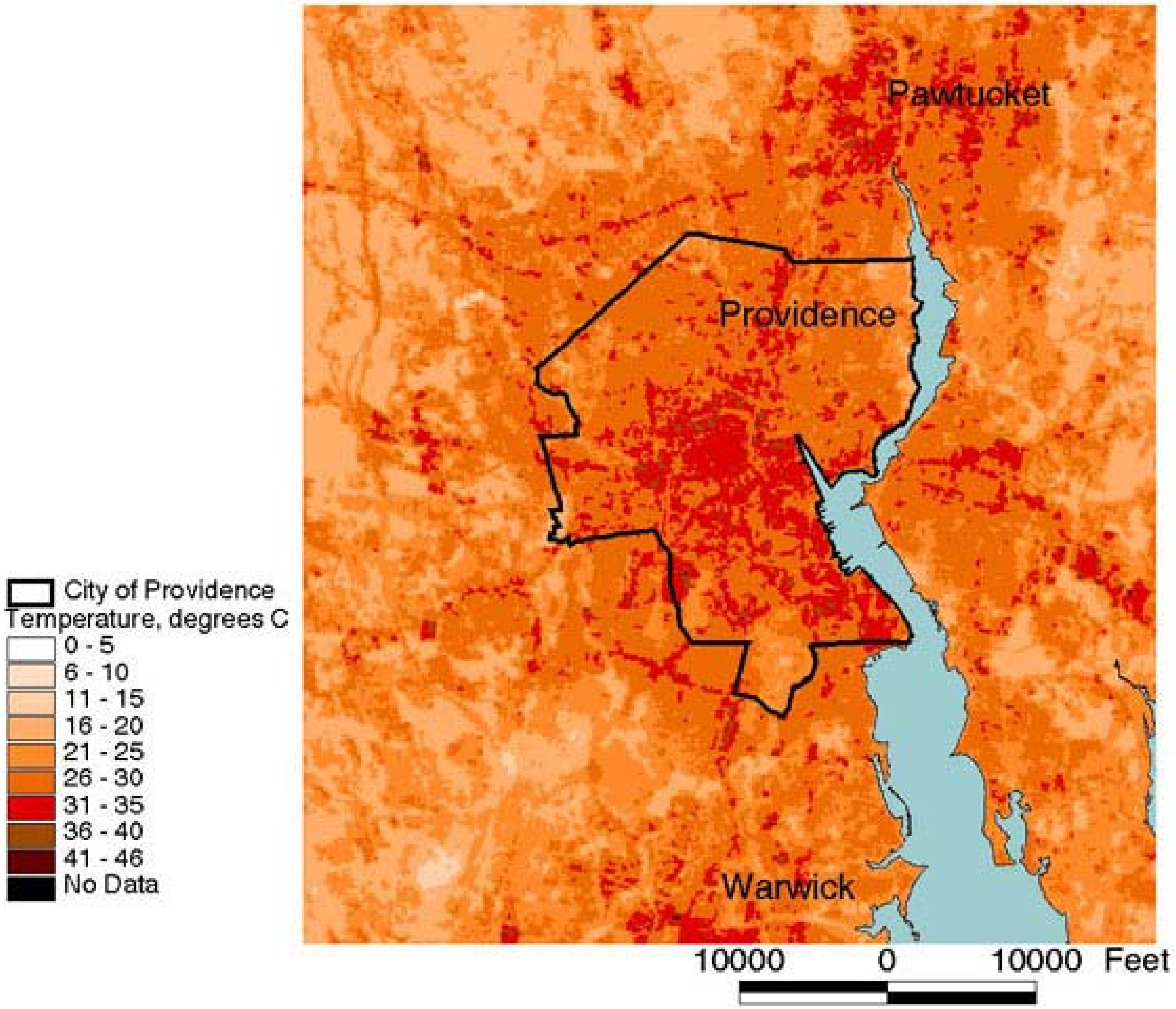
Year



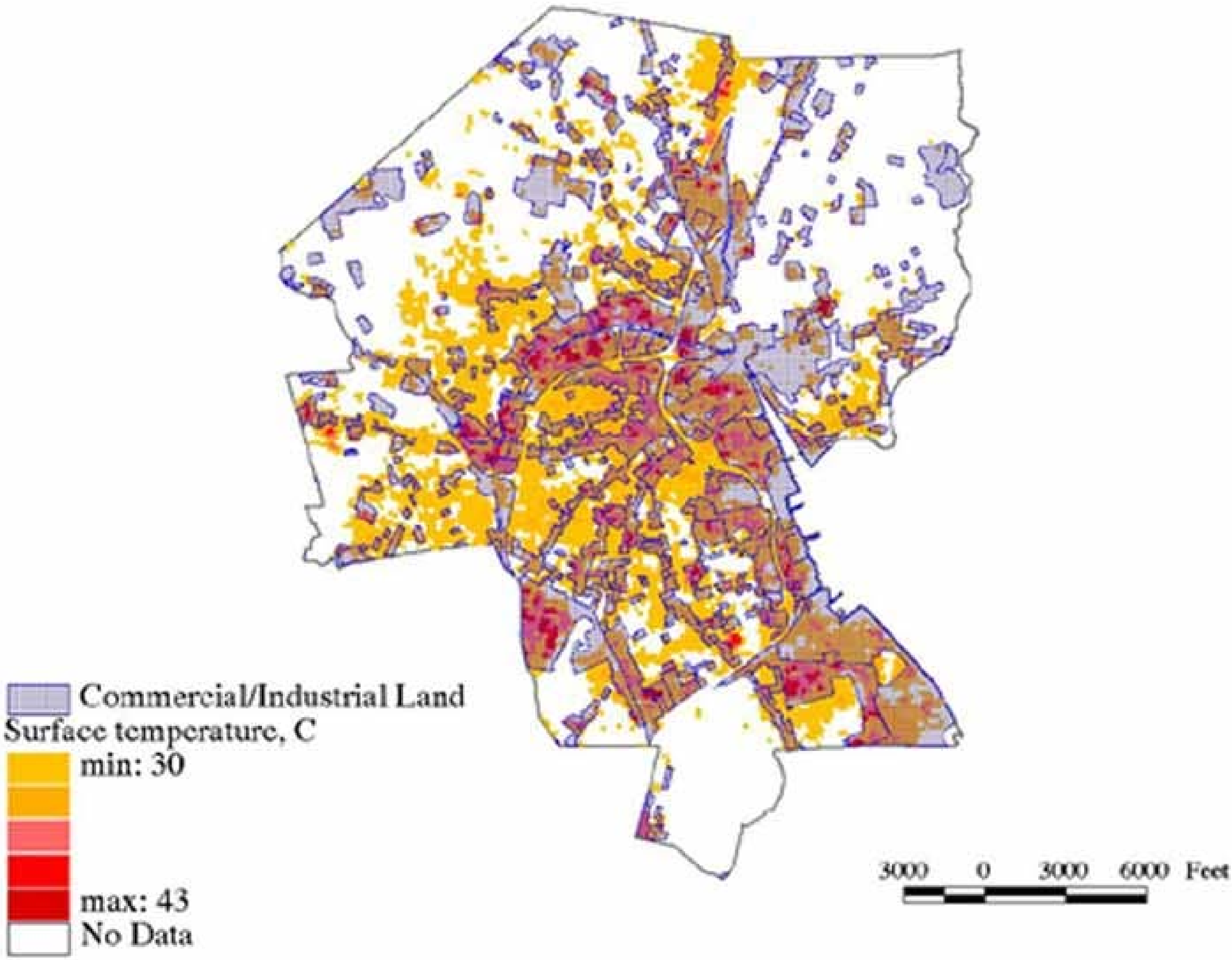
Heat island effect is a vicious circle. A/C units make heat, which might cool, but make more heat (and CO_2), which requires more cooling...



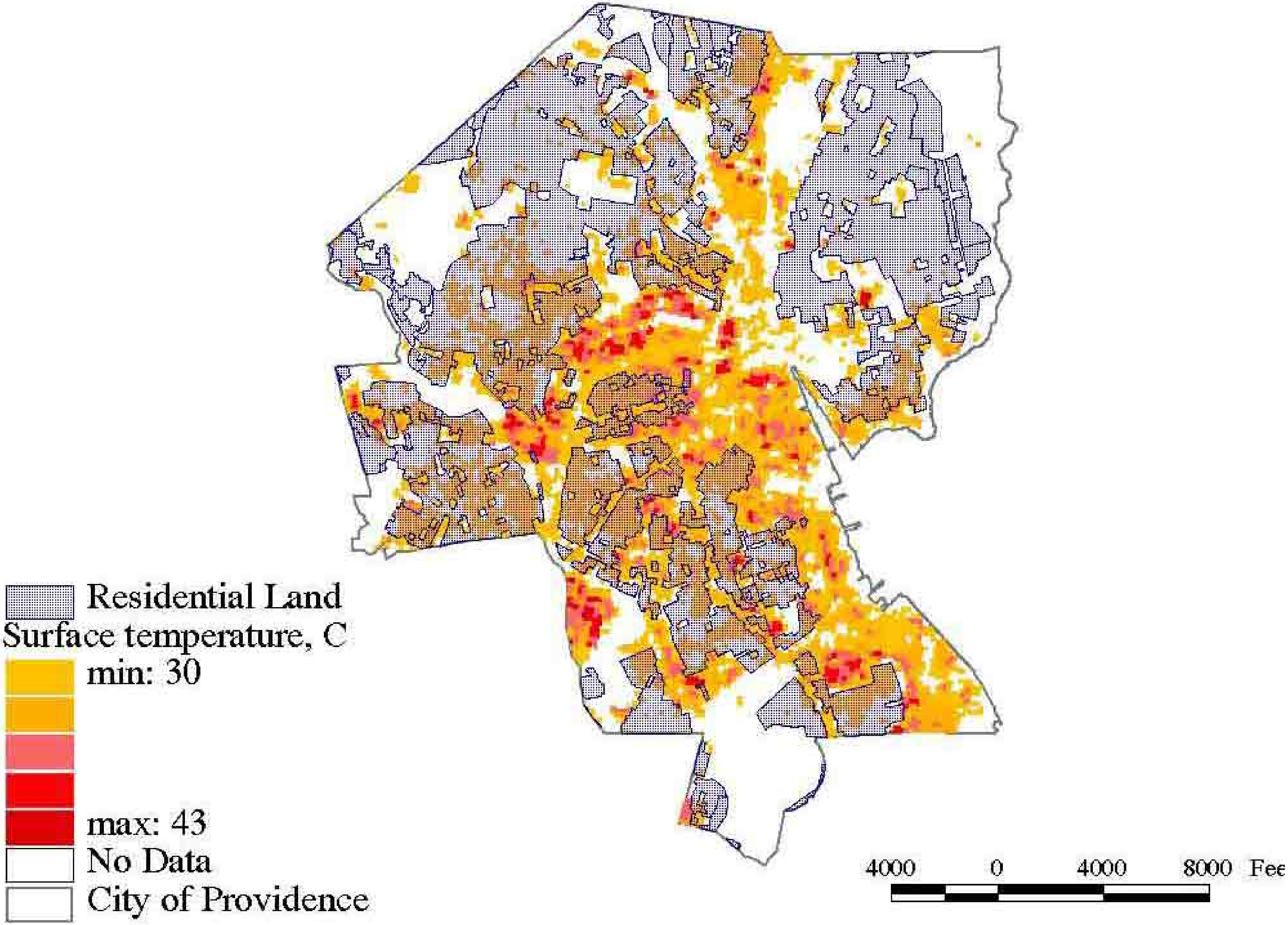
Increase in A/C use worldwide.

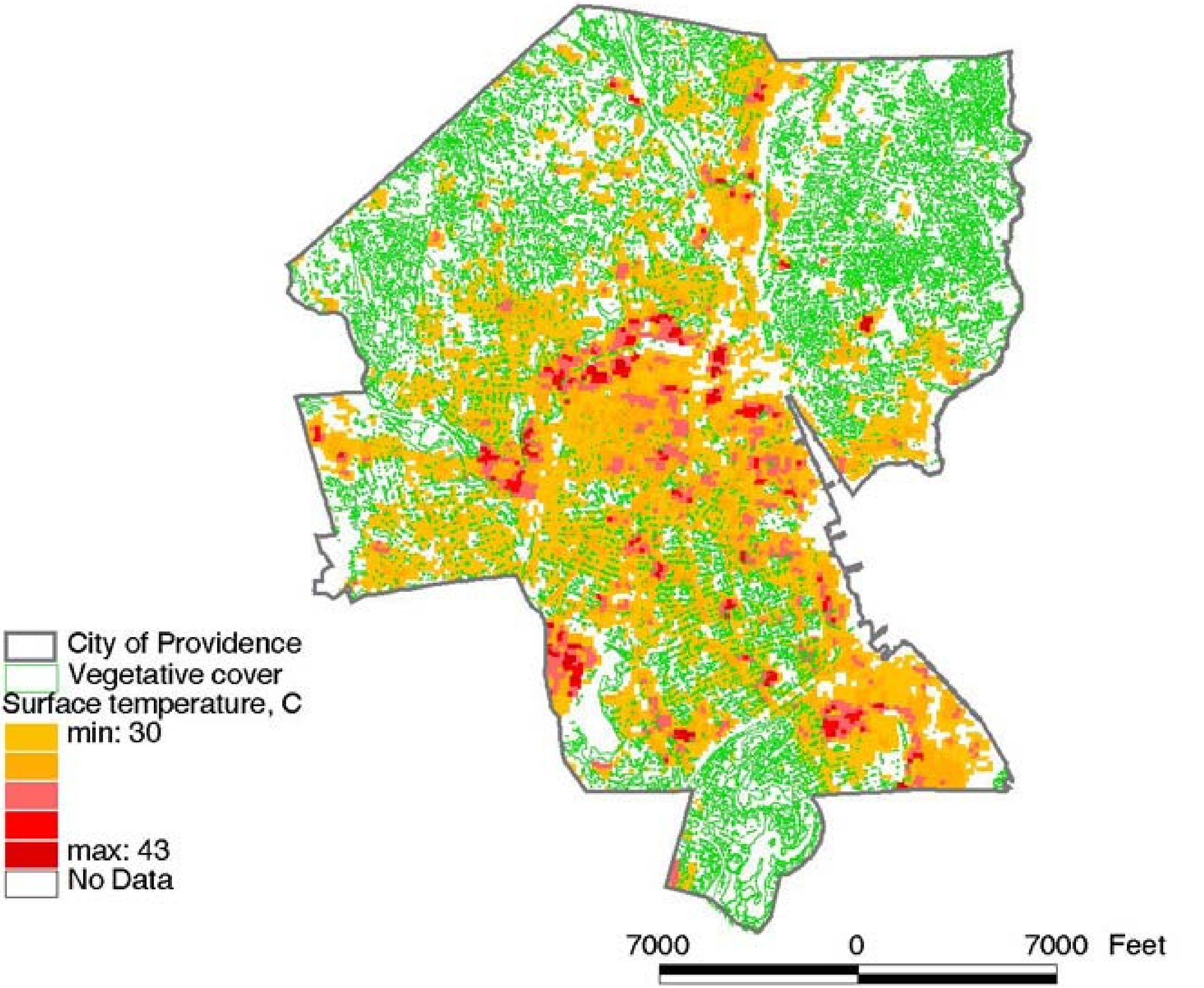


Color-coded thermal map of Providence Metropolitan area



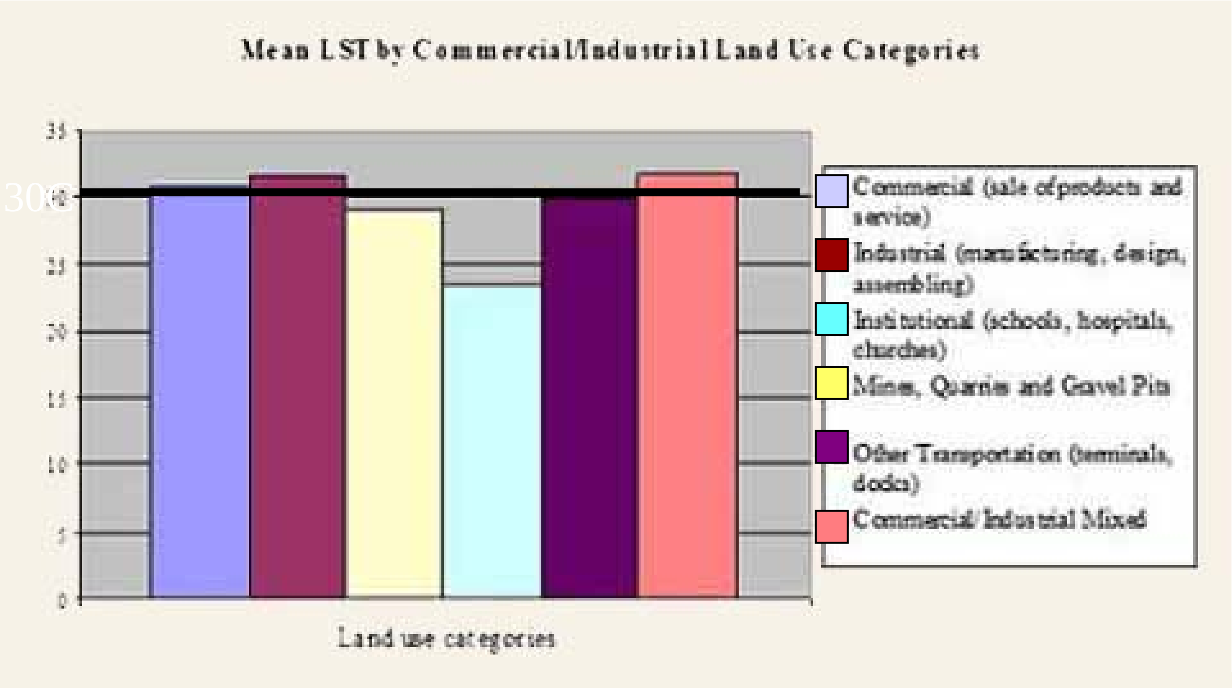
Land use affects overall temperatures.


Residential Land
Surface temperature, C
min: 30
max: 43
No Data
City of Providence
4000
0
4000
8000 Fee

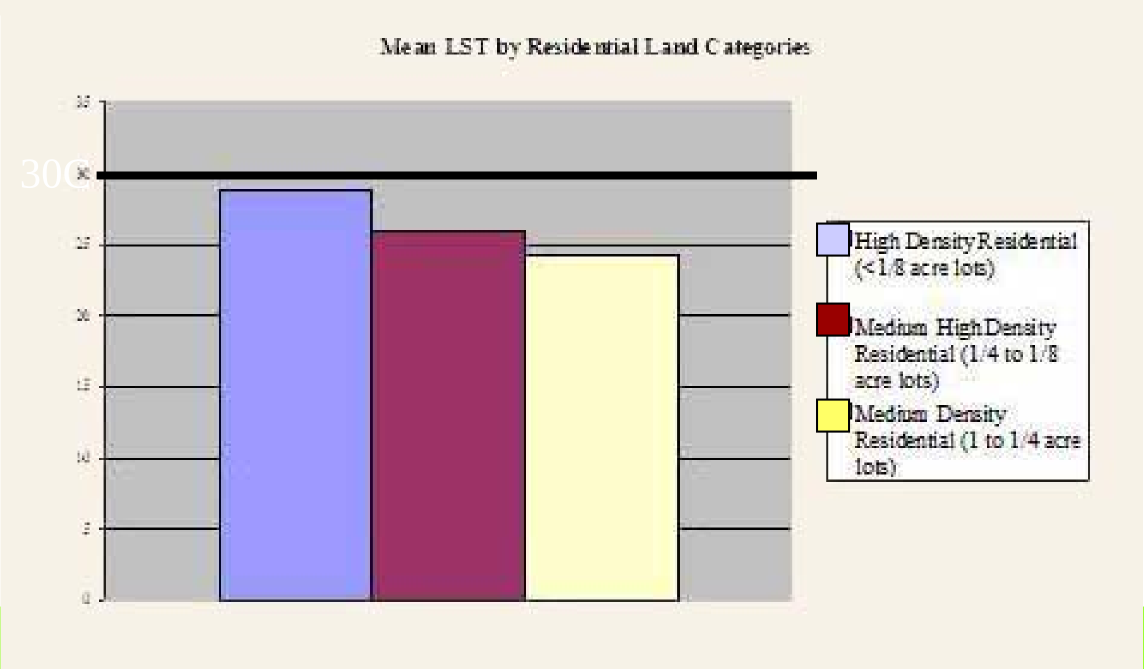


Spatial distribution of urban heat islands and vegetative cover in Providence

This is a thermal map of New York City.

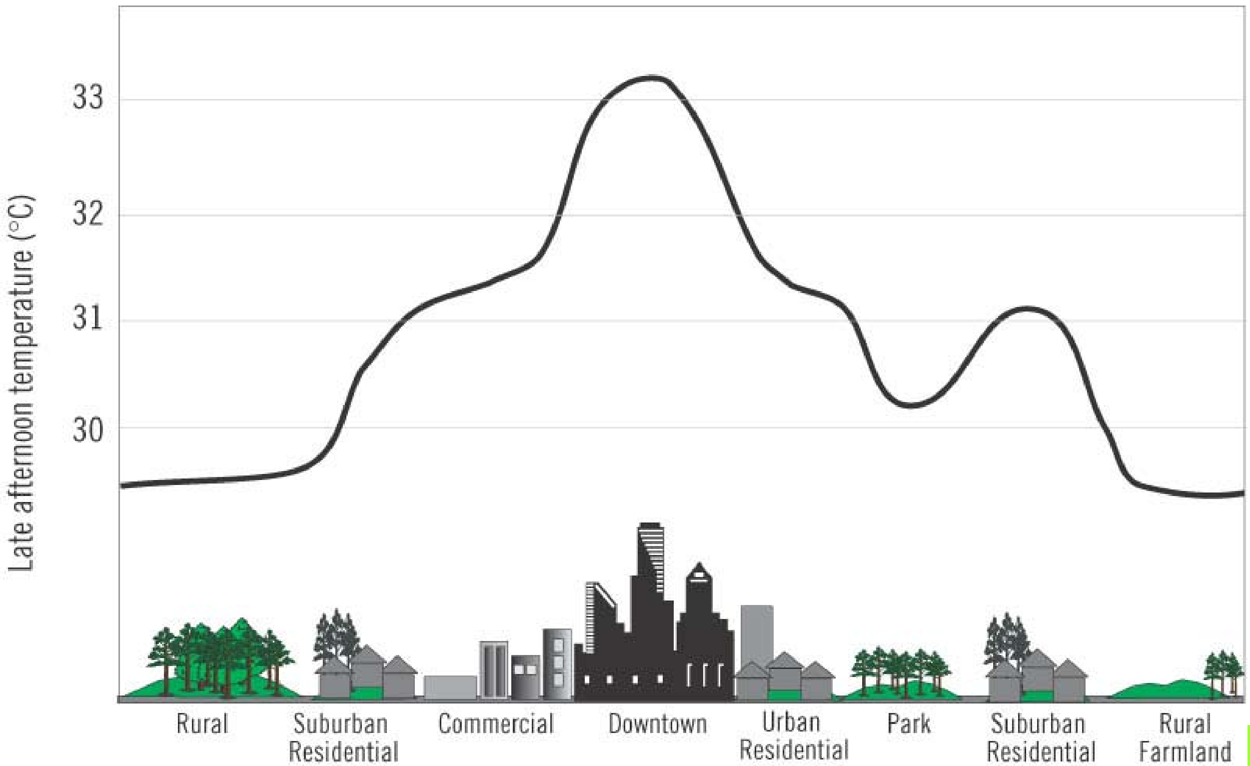


LST means Land Surface Temperature



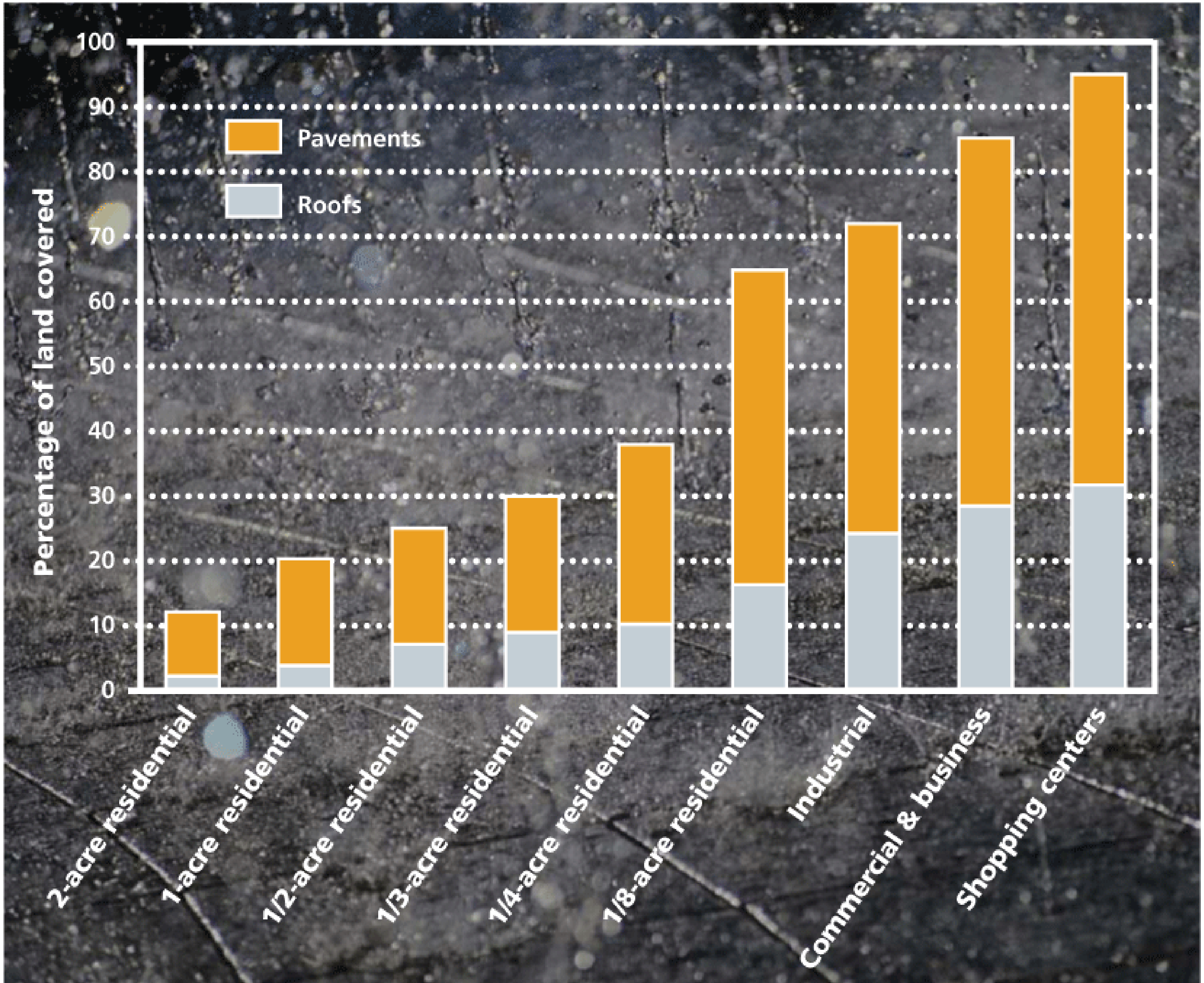
Impervious Materials

Impervious surface materials such as asphalt, concrete, and brick heat rapidly after absorbing relatively small amounts of energy, whereas considerably more energy is needed to raise the temperatures of wood, wet mud, and water.

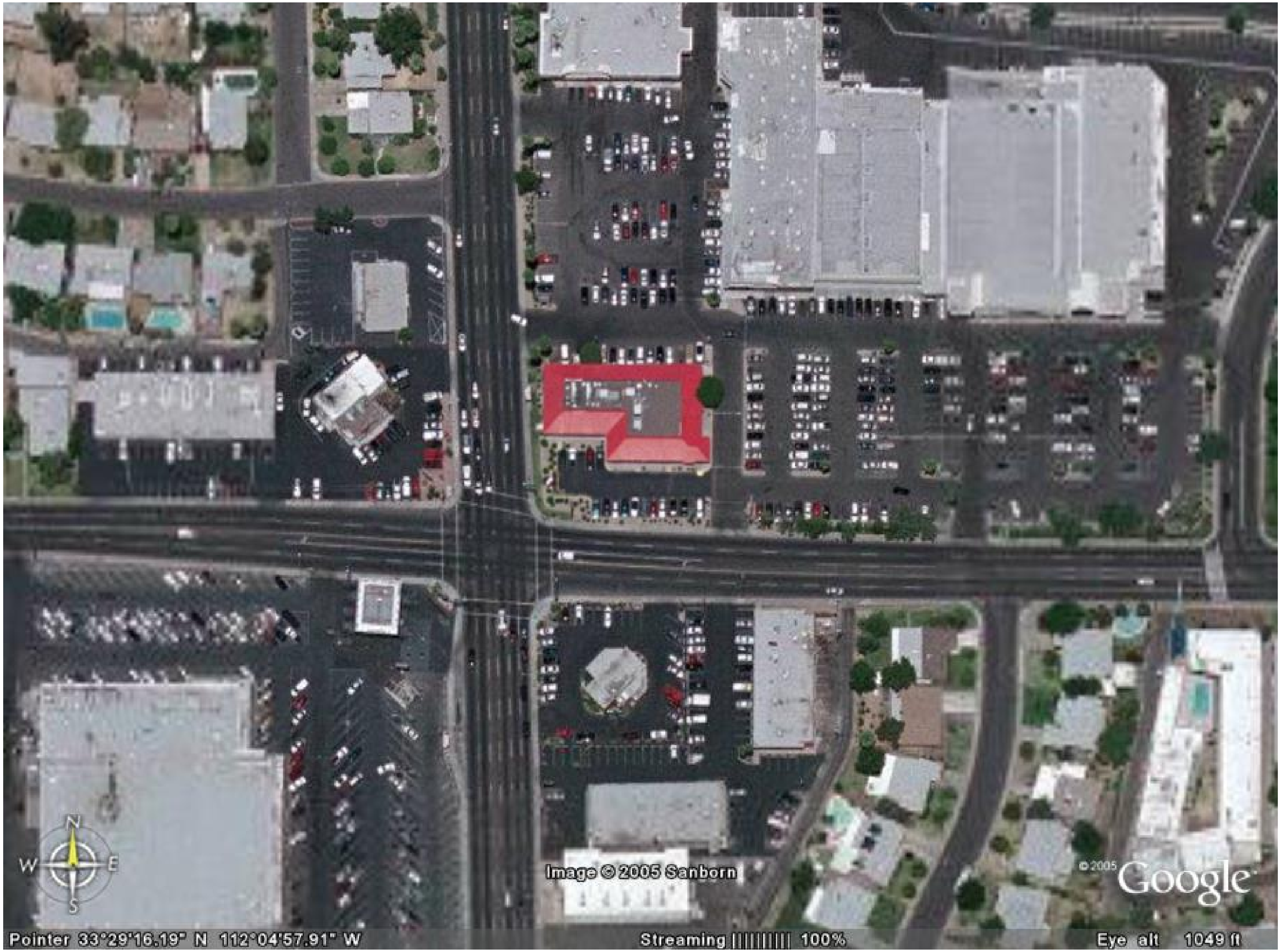


Also, impervious surfaces quickly release heat to the atmosphere. These phenomena, coupled with other factors, results in higher daytime temperatures for urban areas compared to surrounding rural areas.

Impervious Cover of Various Land Uses

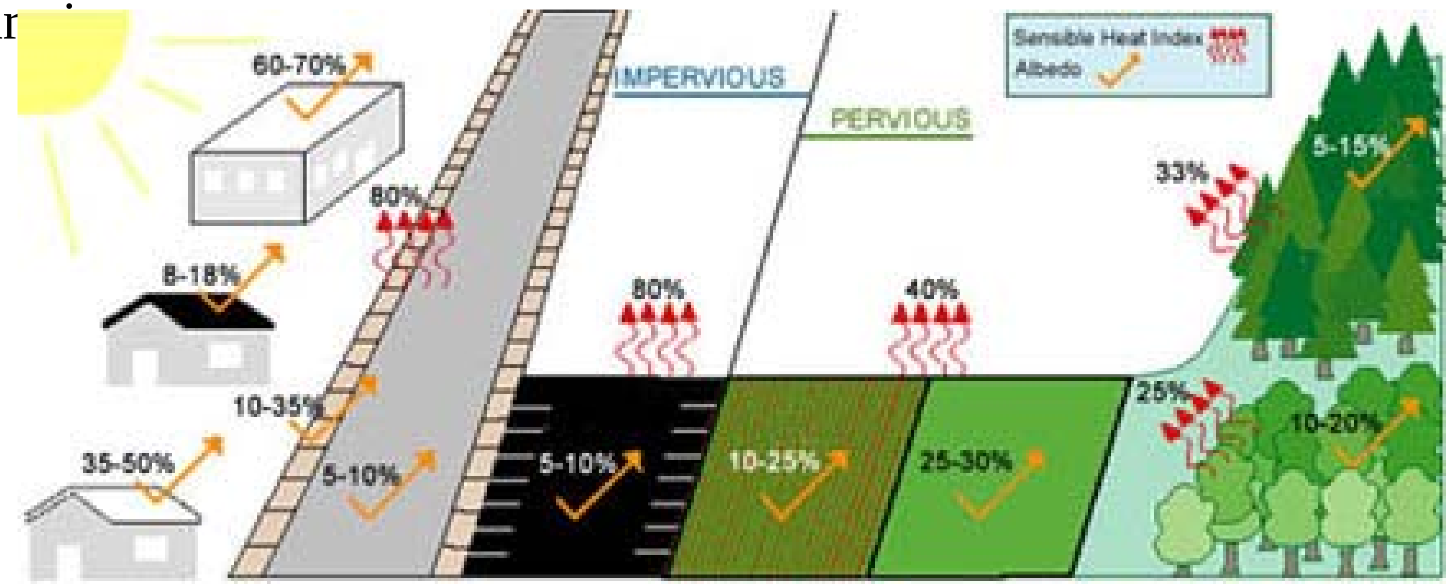


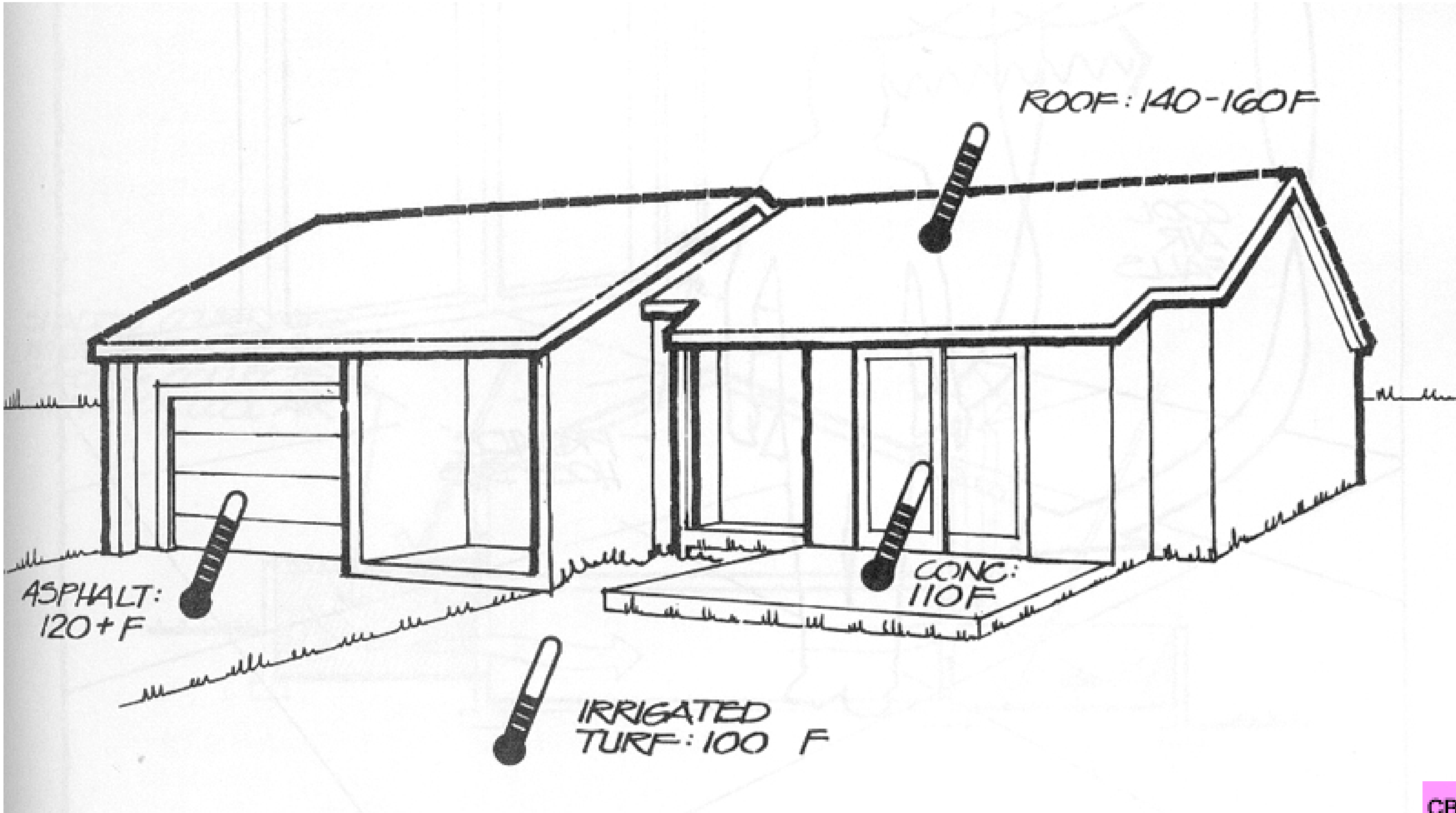
Source: Ferguson B. 2005. Porous Pavements. Boca Raton, FL: Lewis Publishers; page 2.



Phoenix, Arizona: shopping centre with (white) roof and pavement...

The lower albedos, lower specific heat capacities, and higher thermal conductivities of impervious surfaces, coupled with reduced evaporative cooling, serve to increase daytime temperatures over urban areas, especially during the summer. These factors contribute to the phenomenon known as the urban heat island effect. Maximum summer temperatures for urban areas are between 1.0 to 3.0 ° C (1.8 - 5.4 ° F) warmer than surrounding rural areas. The increasing imperviousness of watersheds due to sprawling development does not bode well for human health and comfort given projected increases in Mid-Atlantic heat waves brought on by global warming.



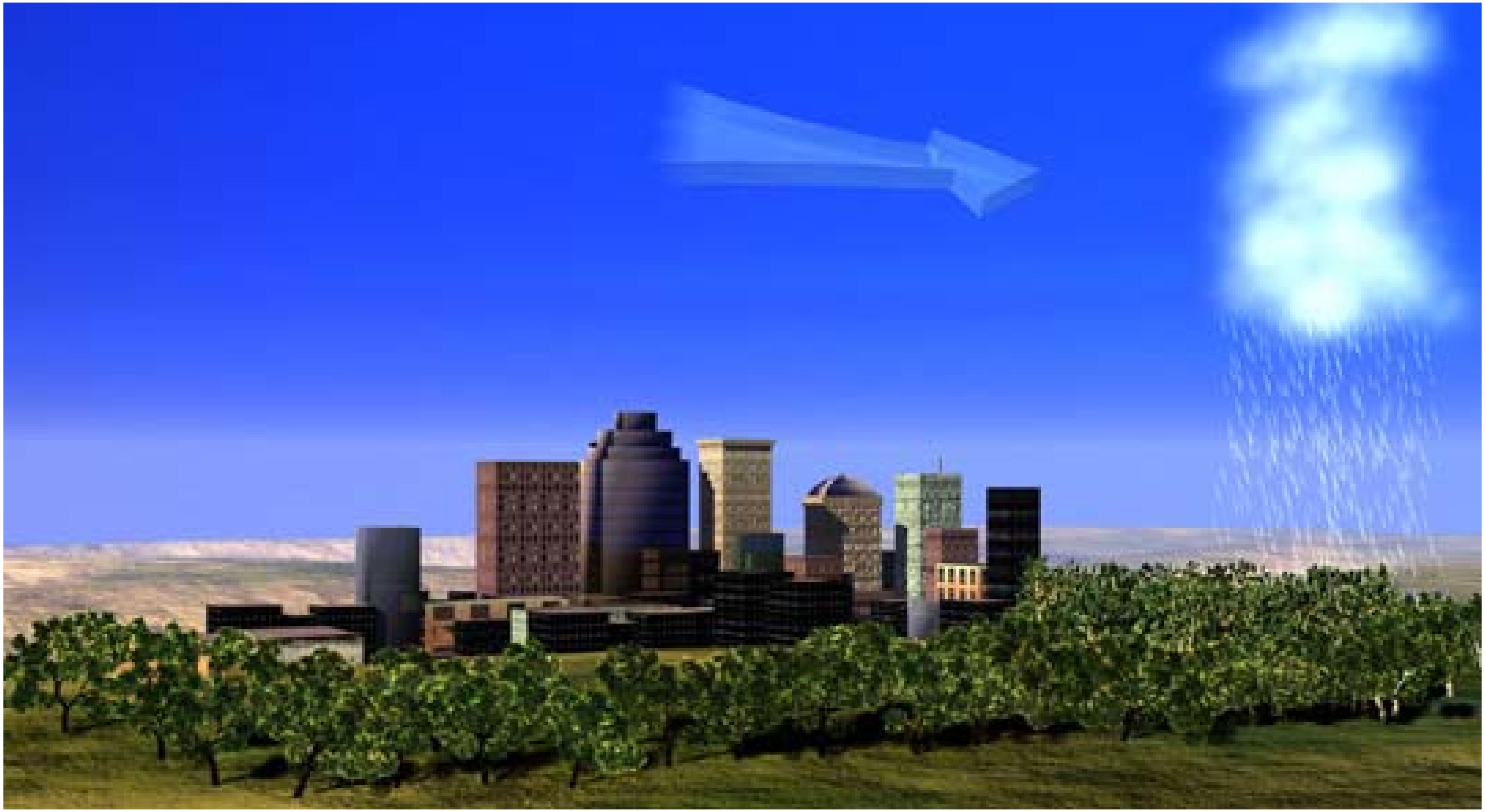


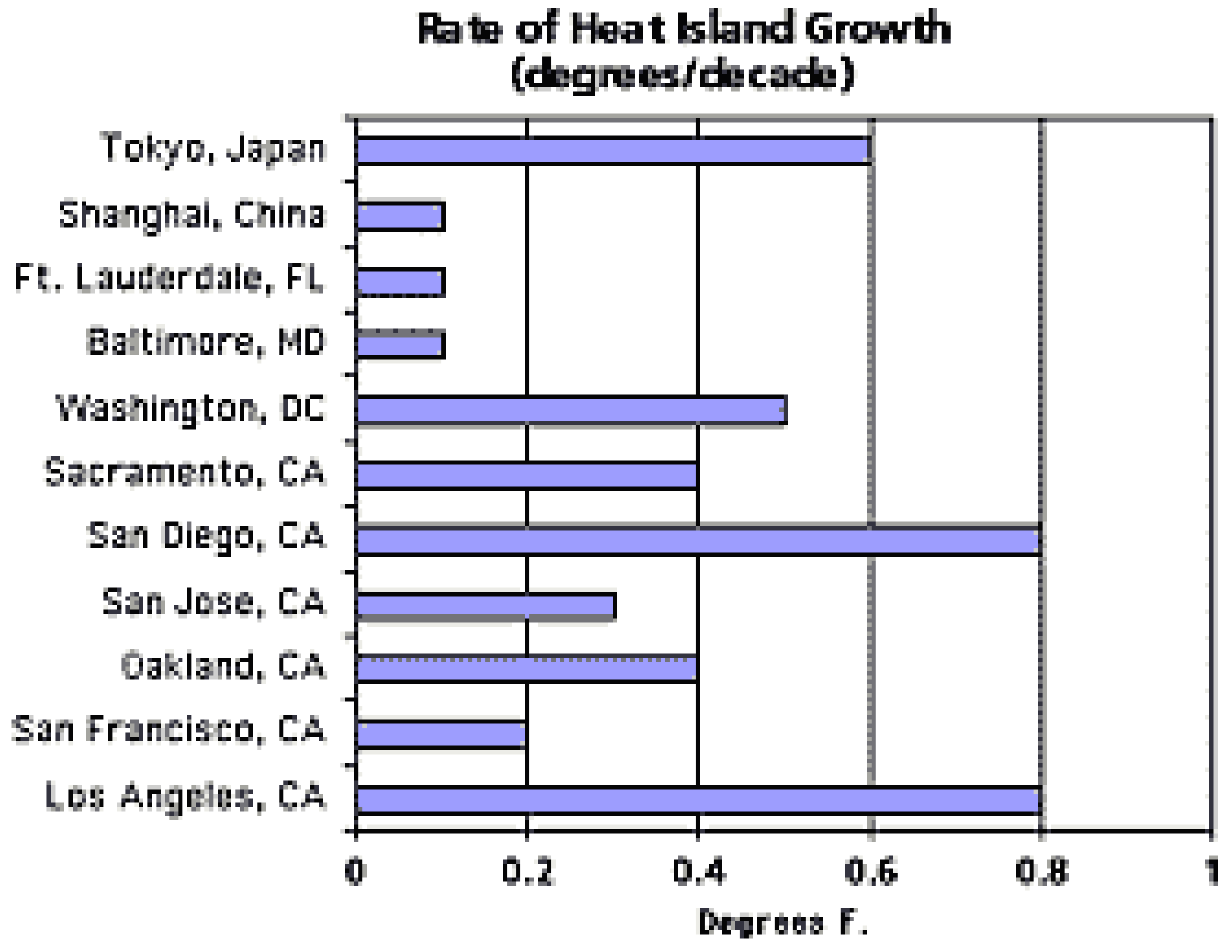
CBD

There is some evidence that the Urban Heat Island effect modifies the rainfall patterns around cities, at least in the summertime.

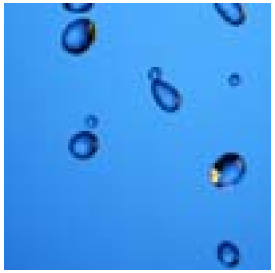
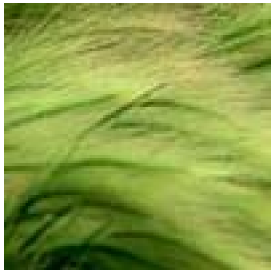
Wind comes across hot air rising over the city...

Rain is produced as this hot moist air cools outside of town...




Rate of Heat Island Growth
(degrees/decade)
Tokyo, Japan
Shanghai, China
Ft. Lauderdale, FL
Baltimore, MD
Washington, DC
Sacramento, CA
San Diego, CA
San Jose, CA
Oakland, CA
San Francisco, CA
Los Angeles, CA
0
0.2
0.4
0.6
0.8
1
Degrees F.

The Effect of Found Site "Natural" Materials

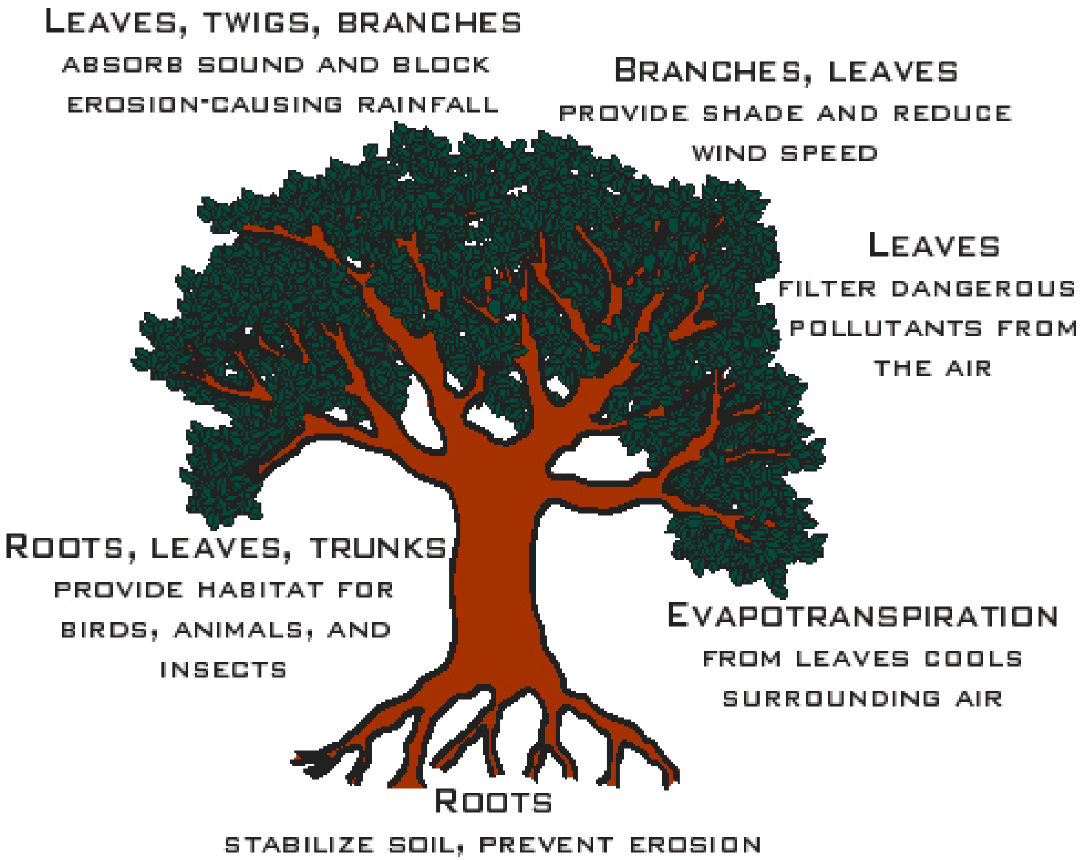


found site

Natural materials and the natural site landscape and configuration will affect the heating or cooling potential of the site.

Replacing natural "soft" materials with "hard or impervious" materials will increase the heat retention potential of the site.

Vegetation: Evapotranspiration



Evapotranspiration occurs when plants secrete or "transpire" water through pores in their leaves--in a way, plants sweat like people do. The water draws heat as it evaporates, cooling the air in the process. A single mature, properly watered tree with a crown of 30 feet can "evapotranspire" up to 40 gallons of water in a day, which is like removing all the heat produced in four hours by a small electric space heater.

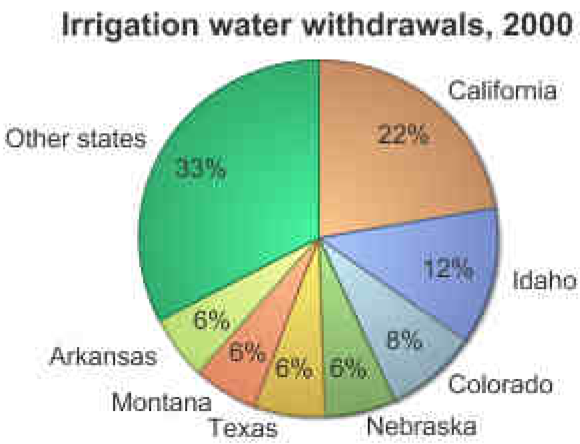
The site needs to be examined for local plant materials and the maximum should be retained. Plants provide cooling and oxygen.

Many municipalities have laws preventing the removal of large caliper trees (30cm+).

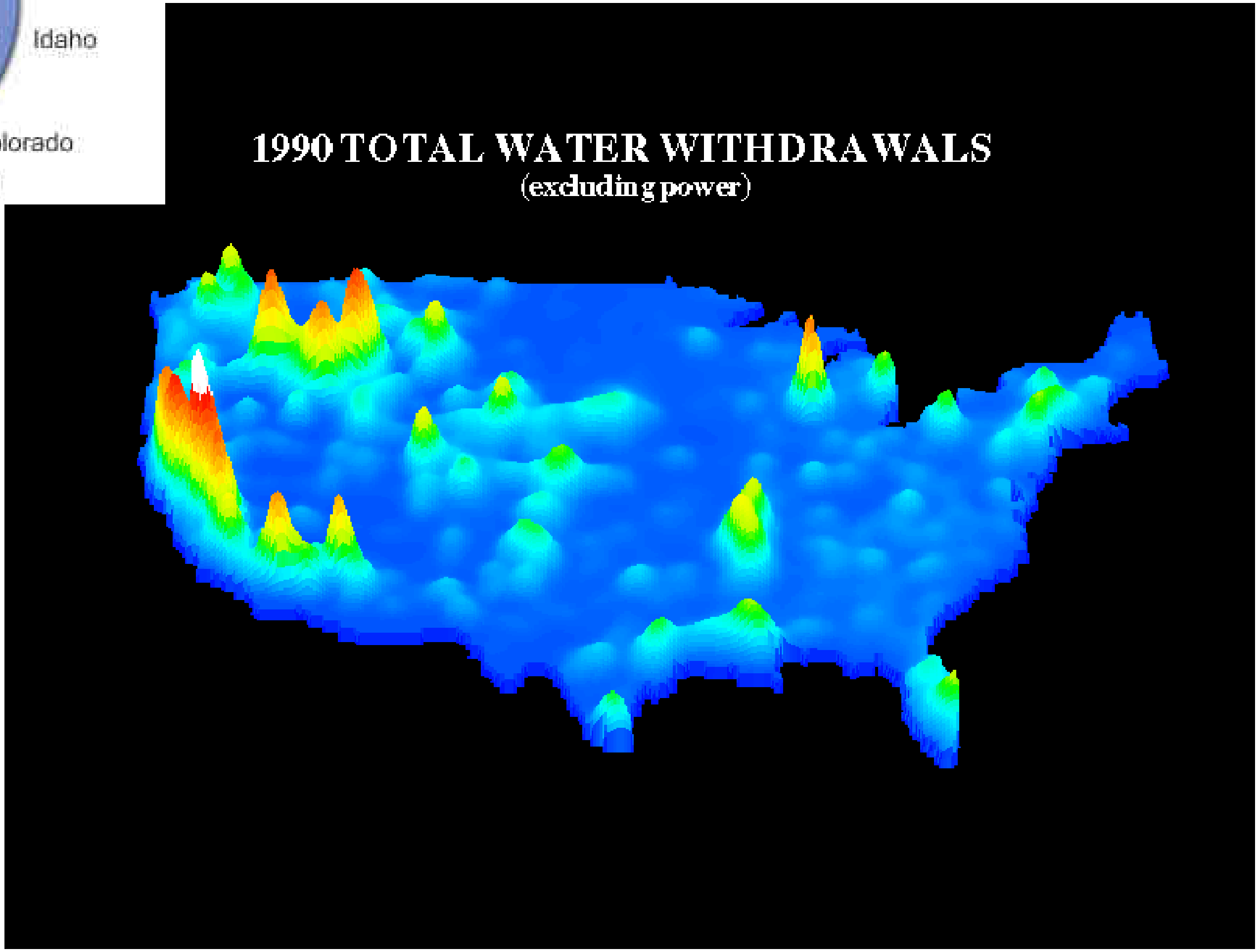
A manicured and mowed lawn is one of the least environmentally effective applications of plant materials due to the high impact that care and maintenance has on the environment.




Maximize the addition of indigenous, local species to the site through landscaping as this type of vegetation typically needs less water to survive.



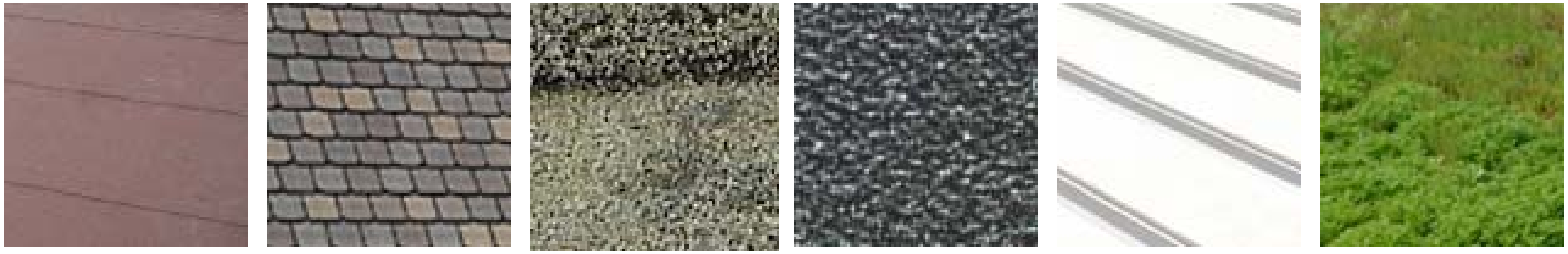
Because the landscaping choices that YOU make affect the net consumption of water for irrigation.



Although coastal regions benefit from natural cooling, smaller bodies of water also can cool the local environment.

Fountains, pools, small water features, major and minor water retention ponds, can all be used to cool the microclimate.

The Effect of Roofing Choices



roofs

The choice of roofing material critically impacts heat retention.

~ Dark materials absorb heat, which is redirected to the urban atmosphere, where greenhouse gasses trap it in place.

~ Light materials reflect the heat (aka "cool roofs").

~ Green roofs stay cool and produce oxygen.

Rooftops present a significant surface area to collect the sun’s heat.

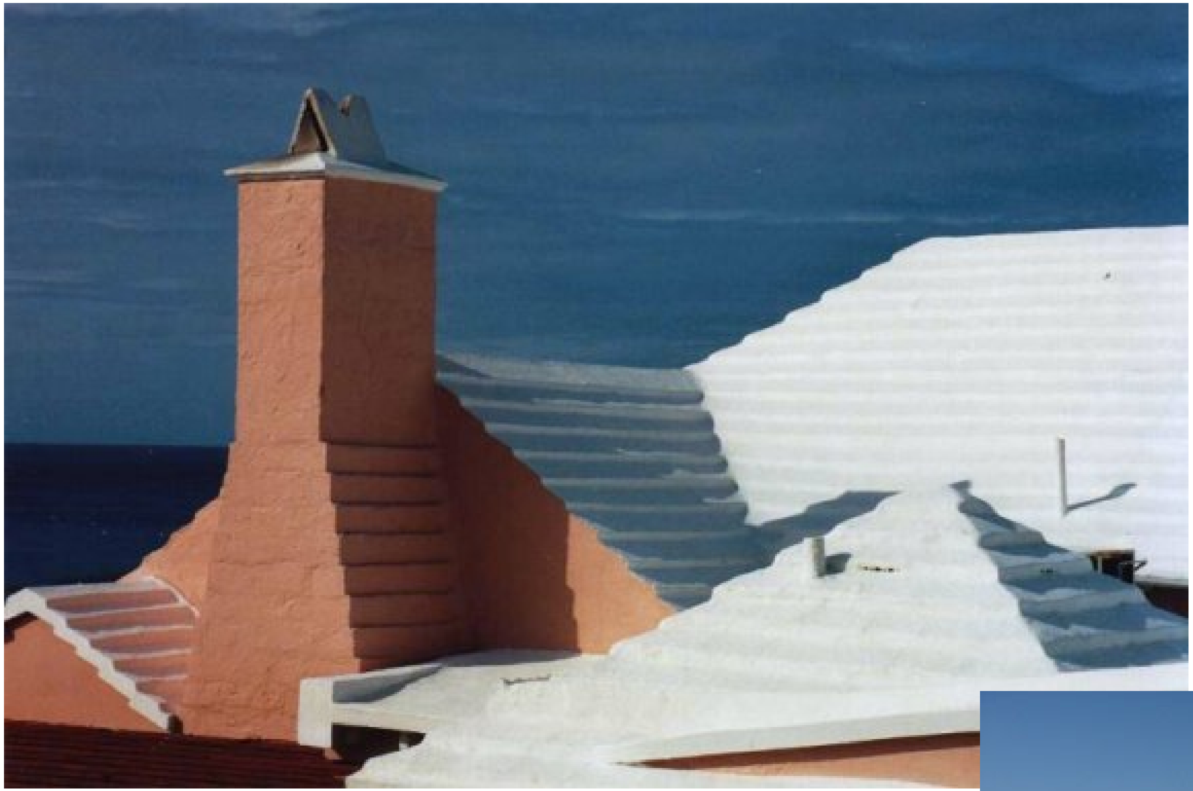
Traditional roofs finished in asphalt shingles, built-up-roof (BUR), and modified BUR all cause heating of the environment and are also made with petroleum products.

Cool Roofs Theory

Cool roof materials have two important surface properties: a high solar reflectance or albedo and a high thermal emittance. Solar reflectance is the percentage of solar energy that is reflected by a surface. Thermal emittance is defined as the percentage of energy a material can radiate away after it is absorbed.

Island of Santorini

Vernacular architecture in hot climates have normally finished roofs in light colours to reflect heat as well as to provide a clean surface for water collection.

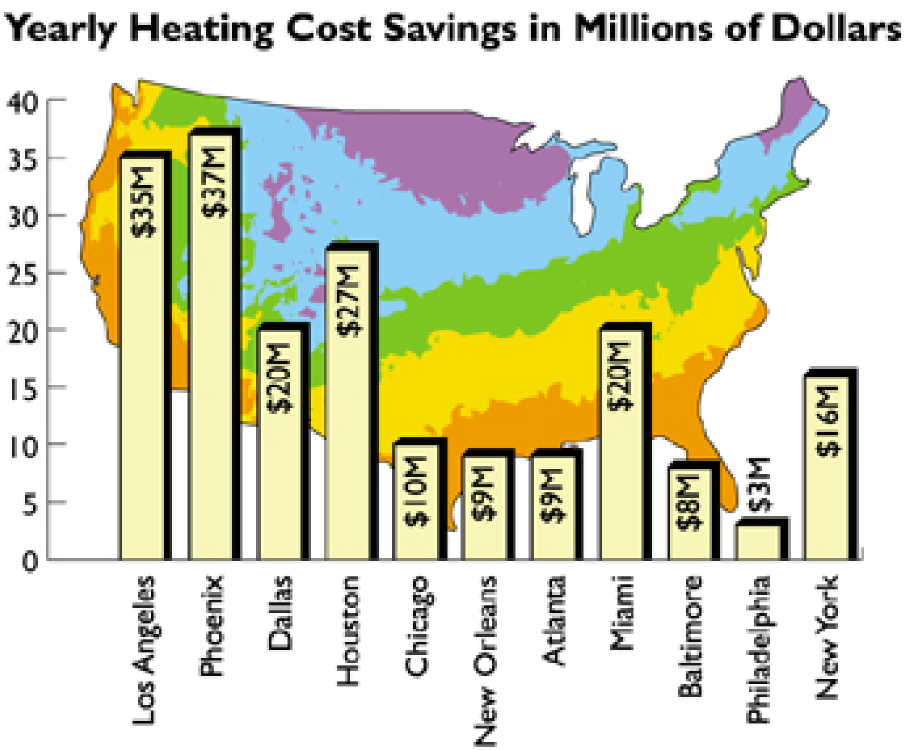


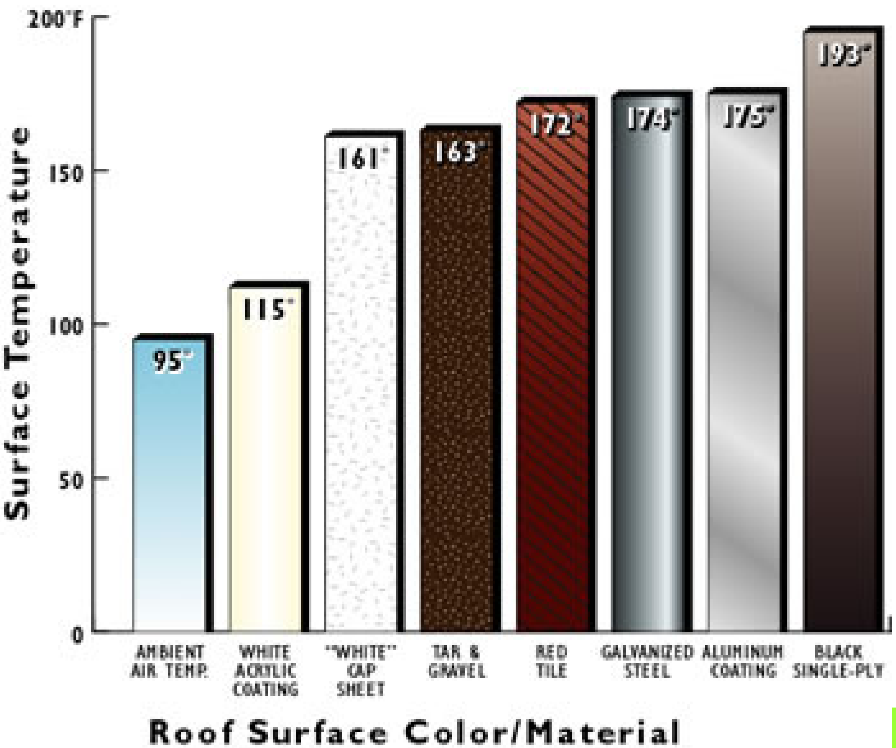
Bermuda

This type of roof is used in island climates where fresh water is limited, to facilitate cleaner rain collection.

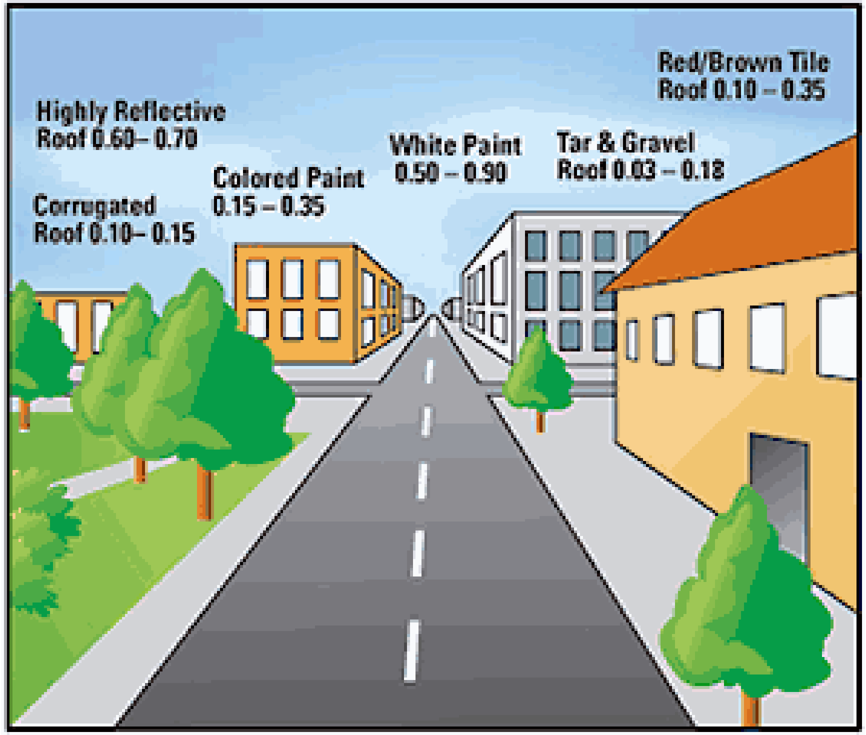
Santorini, Greece

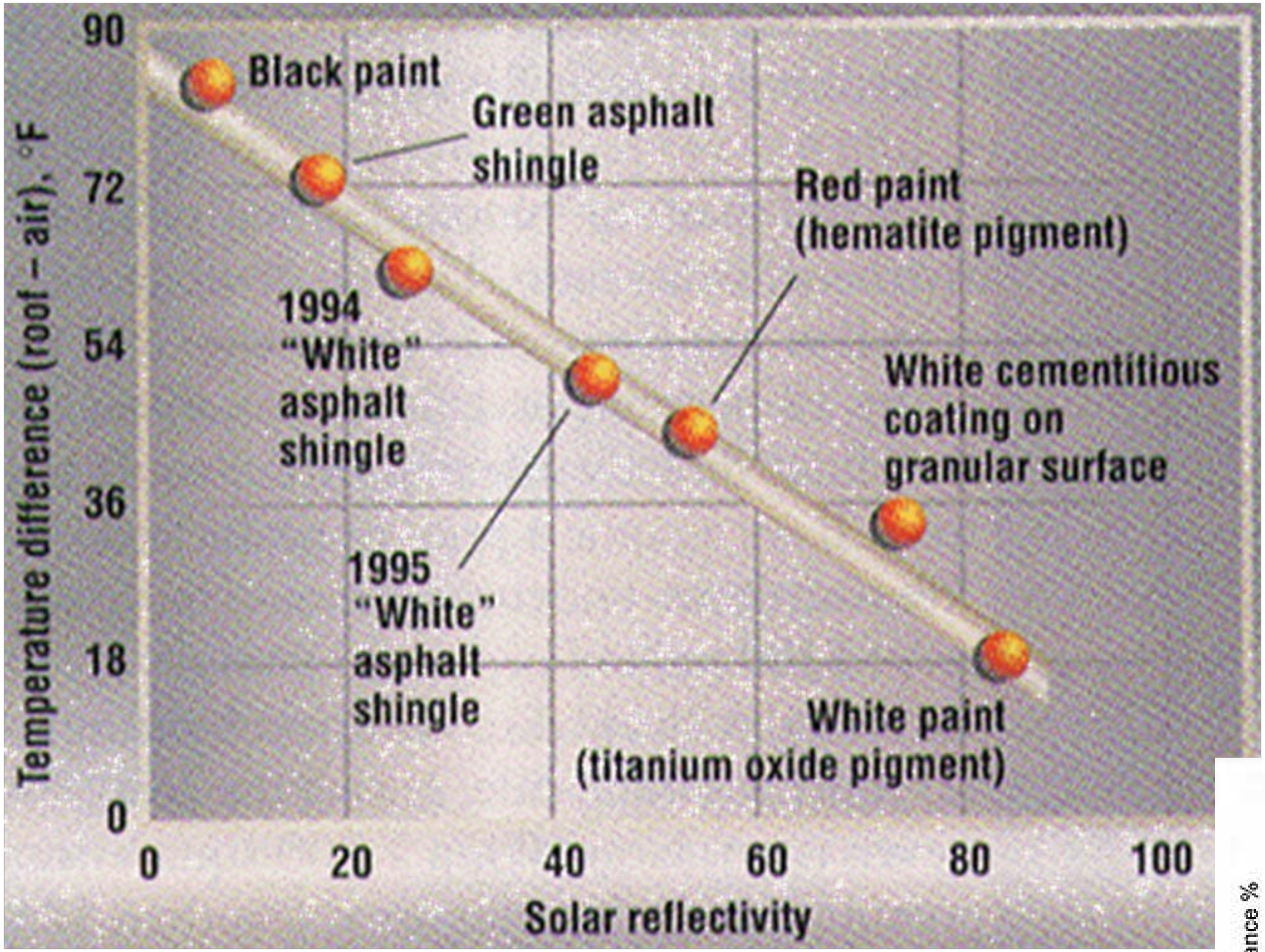
In a study funded by the U.S. EPA, the Heat Island Group carried out a detailed analysis of energy-saving potentials of light-colored roofs in 11 U.S. metropolitan areas. About ten residential and commercial building prototypes in each area were simulated. We considered both the savings in cooling and penalties in heating. We estimated saving potentials of about $175 million per year for the 11 cities. Extrapolated national energy savings were about $750 million per year.



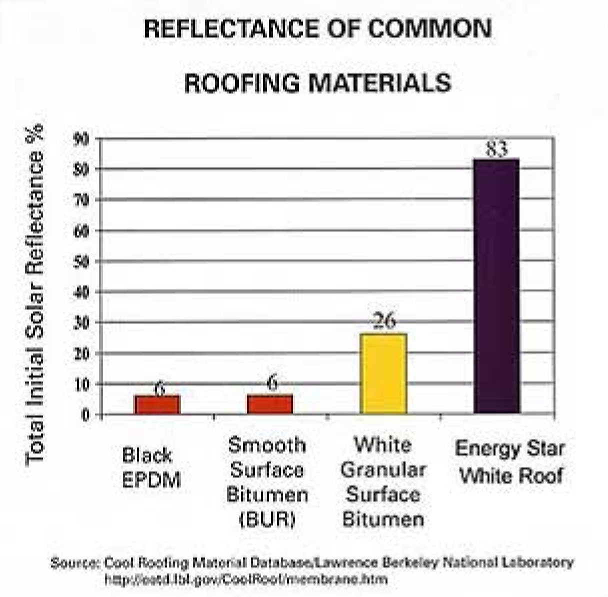


Solar reflectivity is measured according to ASTM E903. Traditional roofing materials have an SRI of between 5% (brown shingles) and 20% (green shingles). White shingles with SRI's around 35% were popular in the 1960s, but they lost favor because they get dirty easily. The current trend is to make white shingles more reflective.





If solar rays are reflected, roofs don't heat up. That means less heat island effect, and lower heat gain in the building, so lower A/C costs.






Various types of roofing come in “white”.

Green Roofs

Green roof technology started in Germany over 30 years ago. Proprietary systems are being looked at with some seriousness in Canada at this point.

Green roofs reduce urban heat island effect and decrease carbon dioxide levels in the city.

They also can provide a higher level of insulation (but not necessarily).

Not all green roofs require a great depth for planting. More later...

Green roof treatments can cover the entire roof, or just a smaller part, depending on the requirements and limitations of the project.

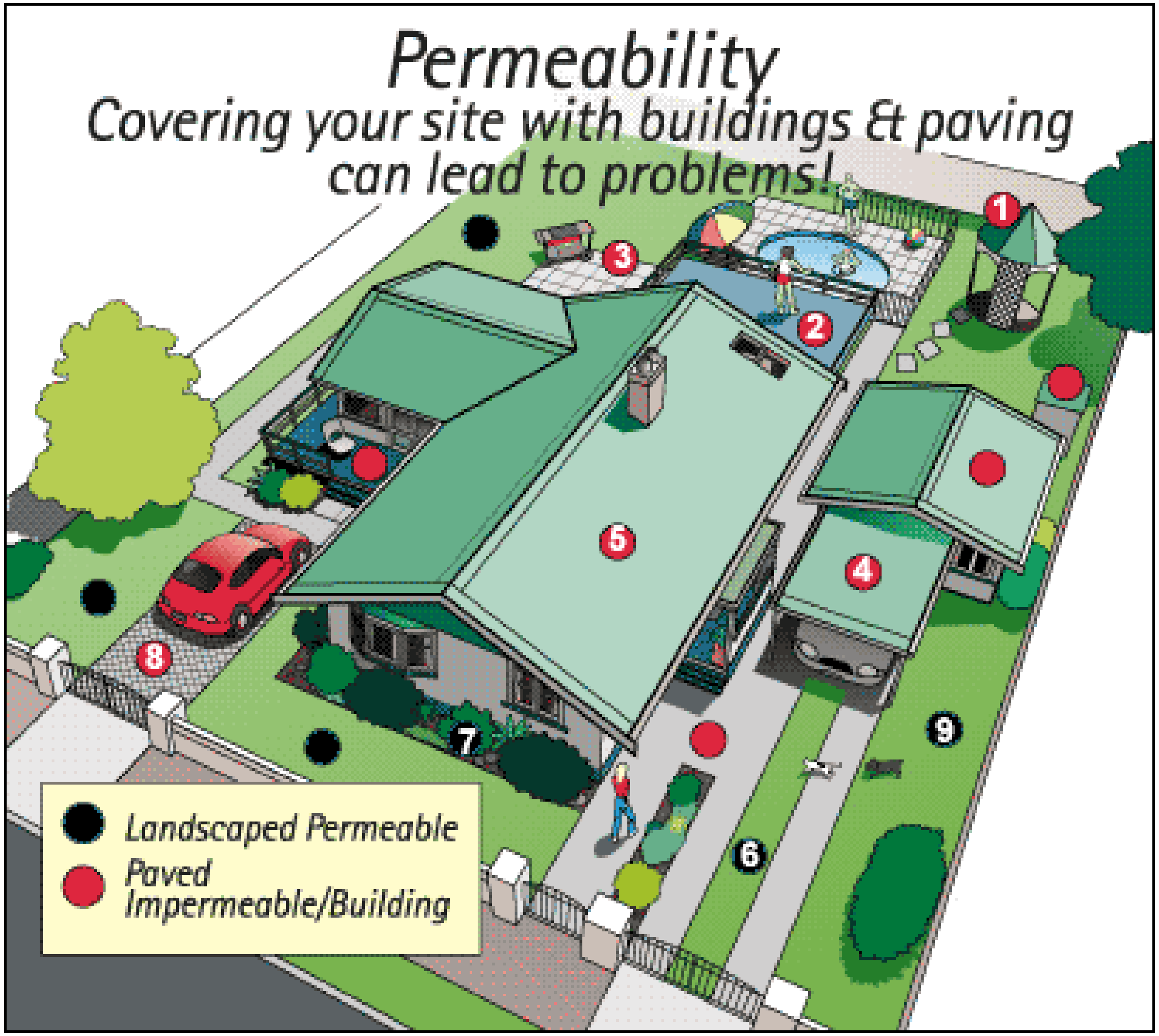
Imagine the environmental benefit and resultant cooling if all of those roofs were either green roofs or cool roofs….

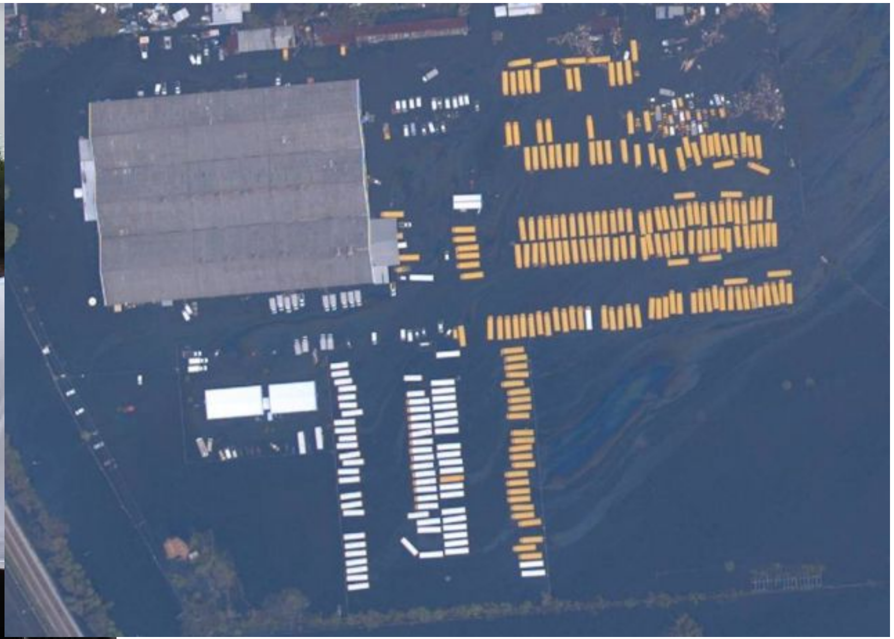
The Effect of Paving Choices

horizontal

"Paving" or the displacement of pervious, green surfaces, with hard surfaces, is a primary cause of negative changes to the local microclimate.

Paving can not only cause heat retention, and overheat the urban environment, but it can also impact water runoff and absorption into the site.

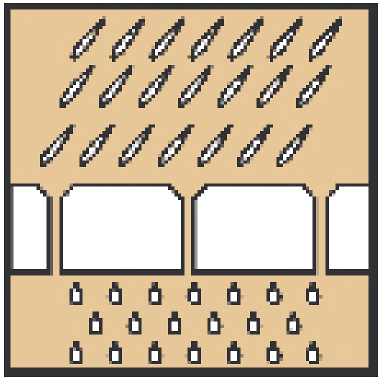

Permeability
Covering your site with buildings & paving can lead to problems!
1
2
3
4
5
6
7
8
9
Landscaped Permeable
Paved Impermeable/Building

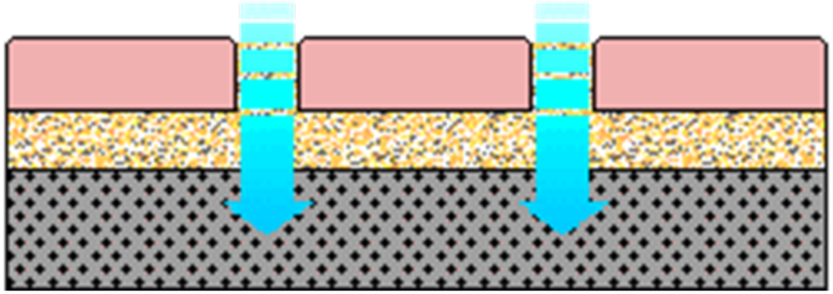


Impervious materials not only cause flooding, but also dump large amounts of water into the sewer system, without benefit of natural cleaning by the ground.

It does not ALL have to look like this...

Shading paved surfaces helps to mitigate overheating.





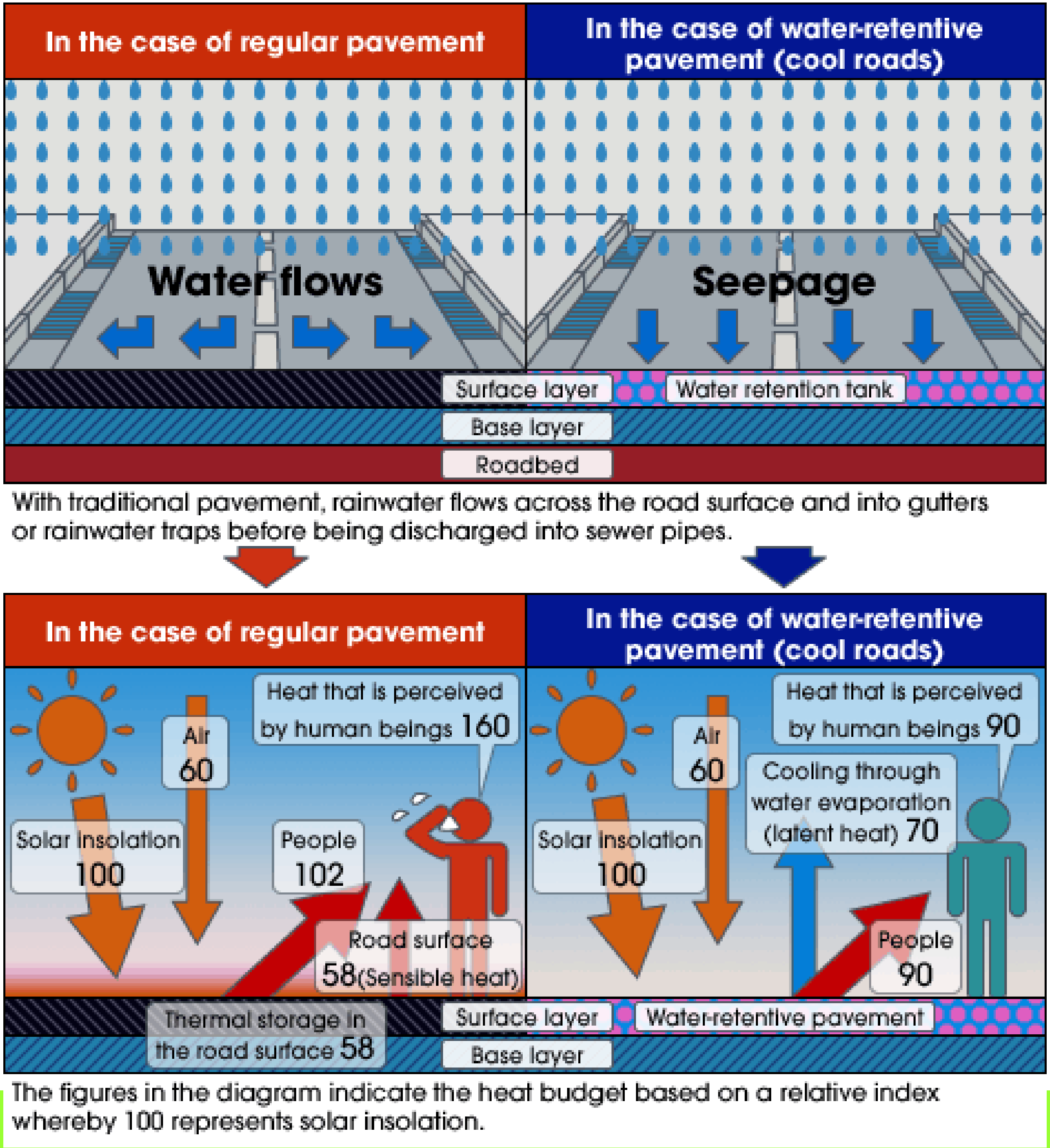
Some paving systems are arranged so that they combine impervious and pervious aspects, giving durability and the ability of water to penetrate between the pavers.

This paver provides a durable driving surface while also allowing some grass to grow up between the units.

Some accommodate gravel or grass.

But you still have to take care to detail this properly or it won’t be very serviceable.

Some durable materials allow the water to go right through them.



Regular impervious pavement versus water - retentive pavement.

Better than asphalt perhaps from an aesthetic perspective, but still impermeable to water.

The Effect of Other Material Choices

Other materials on site, whether they are chosen for walls or accessory structures, will affect the overall tendency of the site to retain heat and create a hot environment.

Shading your walls will help to prevent heat gain.

However, in very cold climates, where the sun angle is very low, material choice can be used TO hold heat in the building and warm up outside spaces.

The selection of wall cladding is very complex and must respond to climate and building science considerations as well.

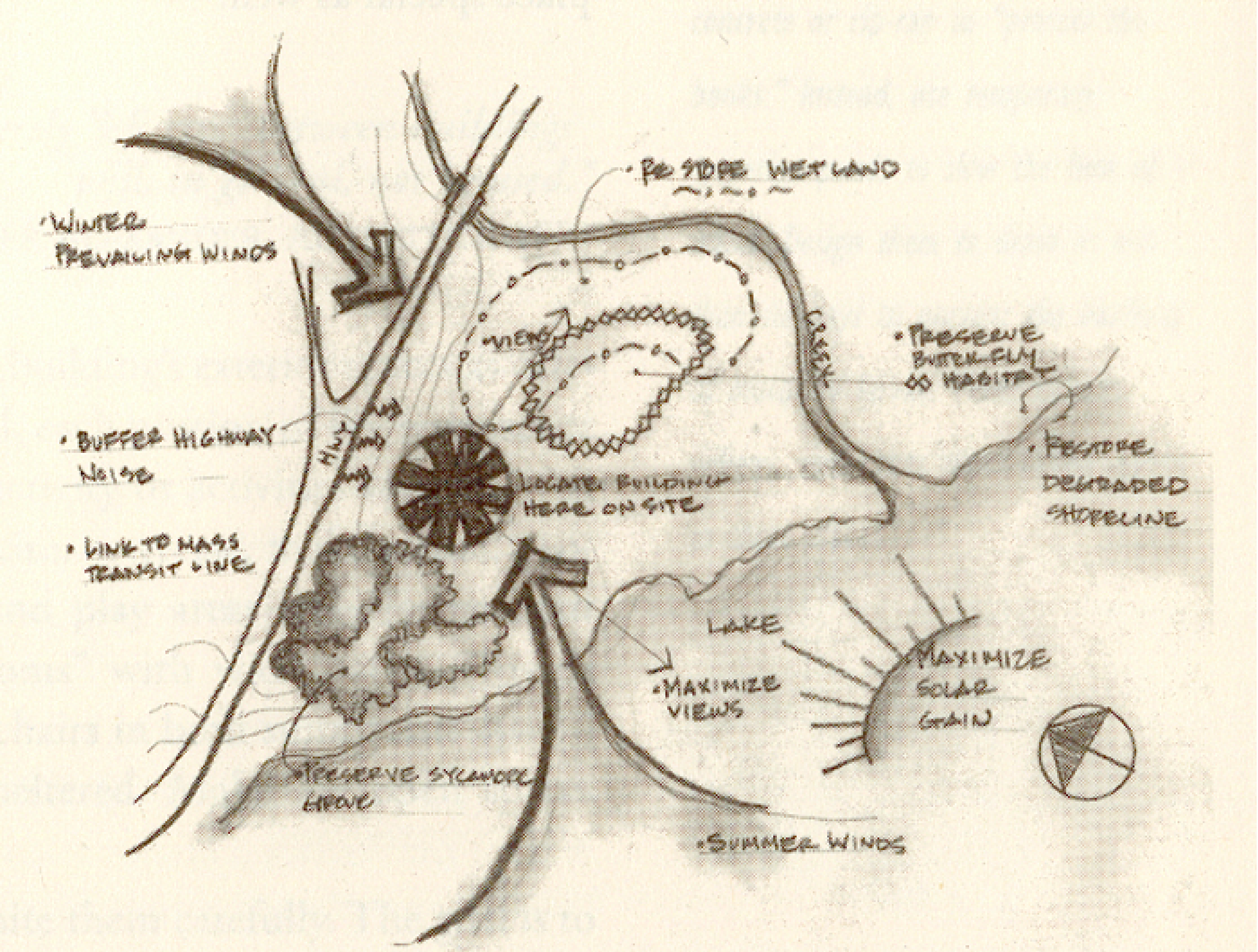
Putting it All Together...

Climate Considerations

A climatic analysis of the site shows the designer to what extent *air temperature*, *solar radiation*, *air movement and relative humidity affect human comfort*.

It will indicate which climatic features to enhance, and which to mitigate at different times of the year, in order to minimize loads on heating or cooling systems in buildings, and to increase the comfort of people both indoors and outdoors.

Climate analysis is also needed to protect the facility from climatic forces such as violent storms and other extremes.



Considerations for building placement

#1 - visit and analyze the site - collect data

Topography

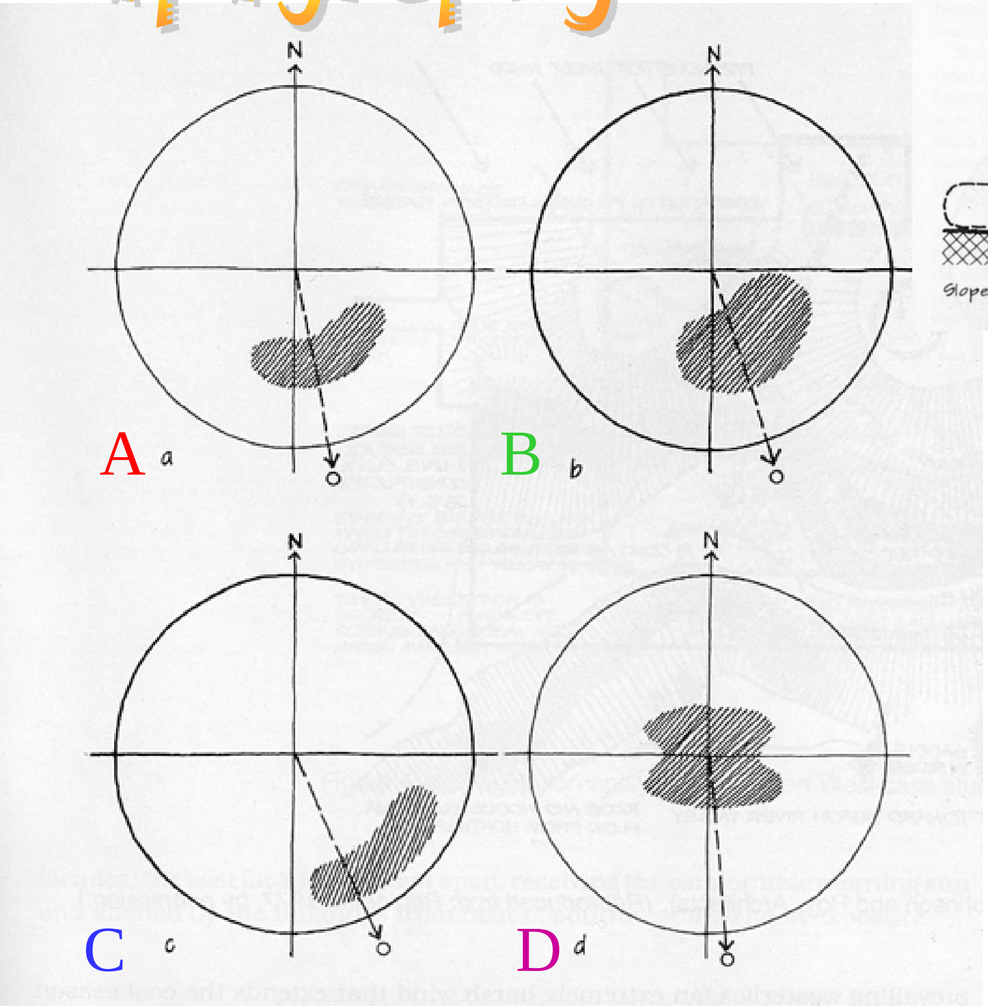
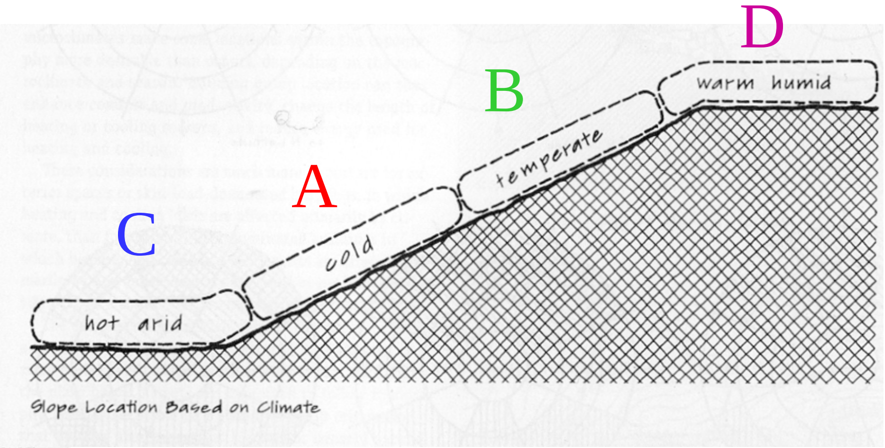


Figure 4.19: Schematic site plans of a hill showing desirable site locations in four climates: (a) cold, (b) temperate, (c) hot arid, and (d) warm humid. *(After Olgyay, 1963.)*



SWL

When building on a hill, each of the 4 climate types results in a different "best build" location for the building.

Topography

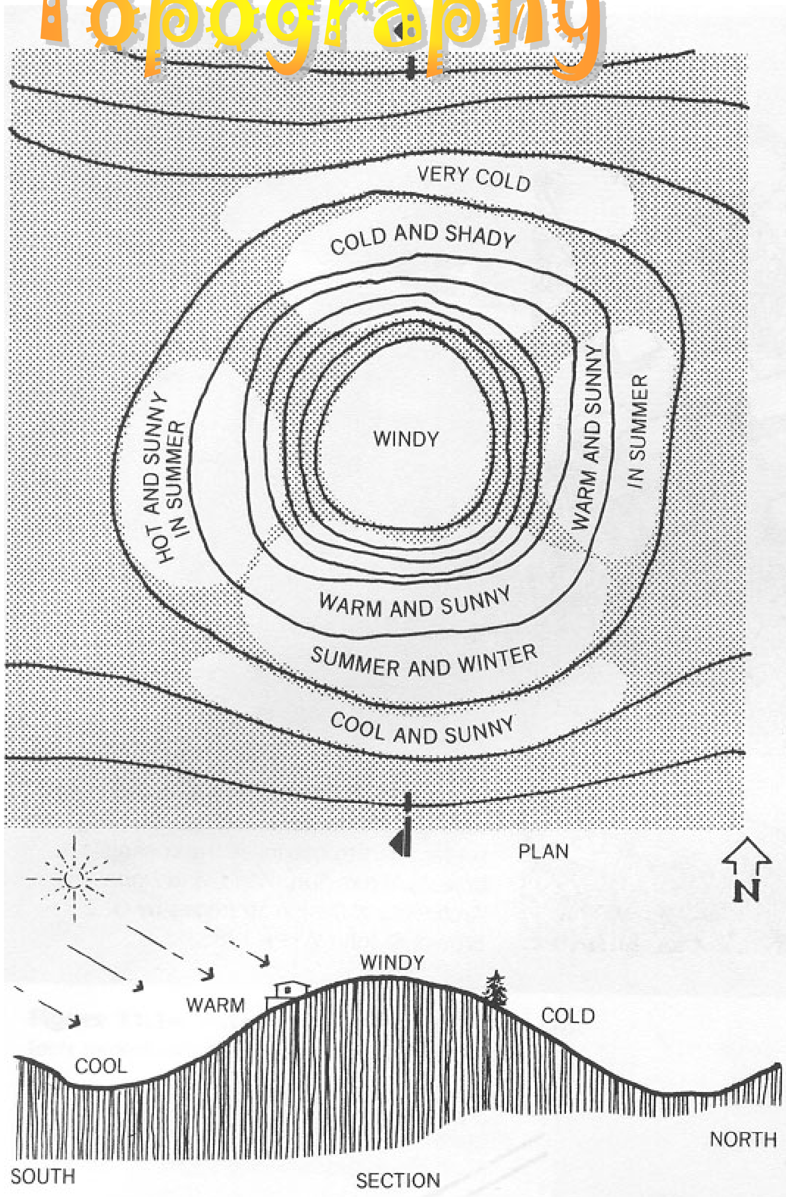


Figure 11.2c Microclimates around a hill.

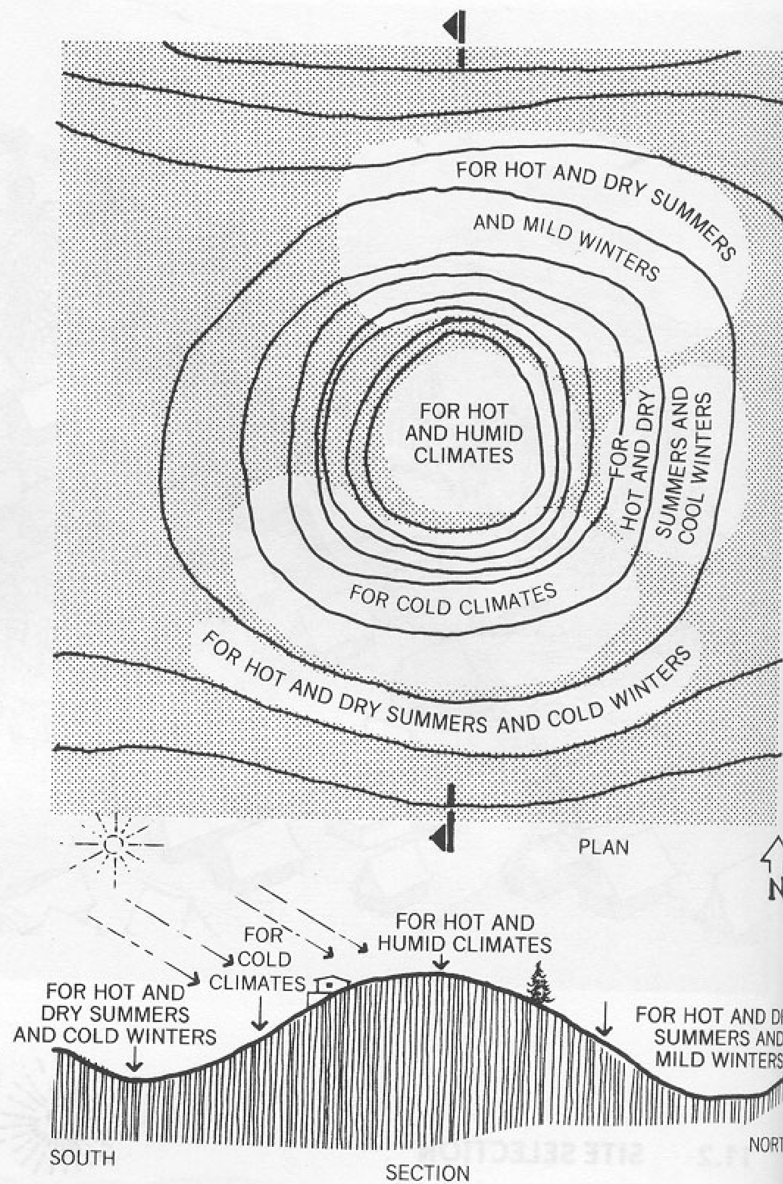


Figure 11.2d Preferred building sites around a hill in response to climate for envelope-dominated buildings.

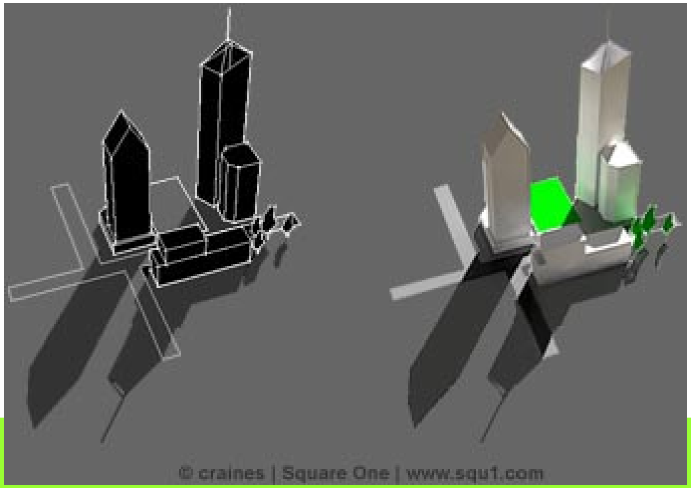
…hills and valleys...

When assessing the climate it is important to:

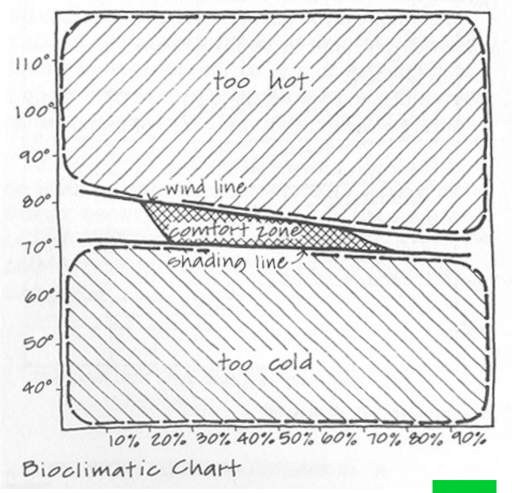
* Prepare a bioclimatic chart on the seasonal variation of outdoor conditions at the site. It is possible to see on such a chart when, and to what degree the climate of the site falls outside a commonly accepted 'comfort zone' and what strategies may be needed to modify the microclimate.

* Identify the prevailing winds in relation to terrain and existing vegetation for their potential influence on outdoor thermal comfort.

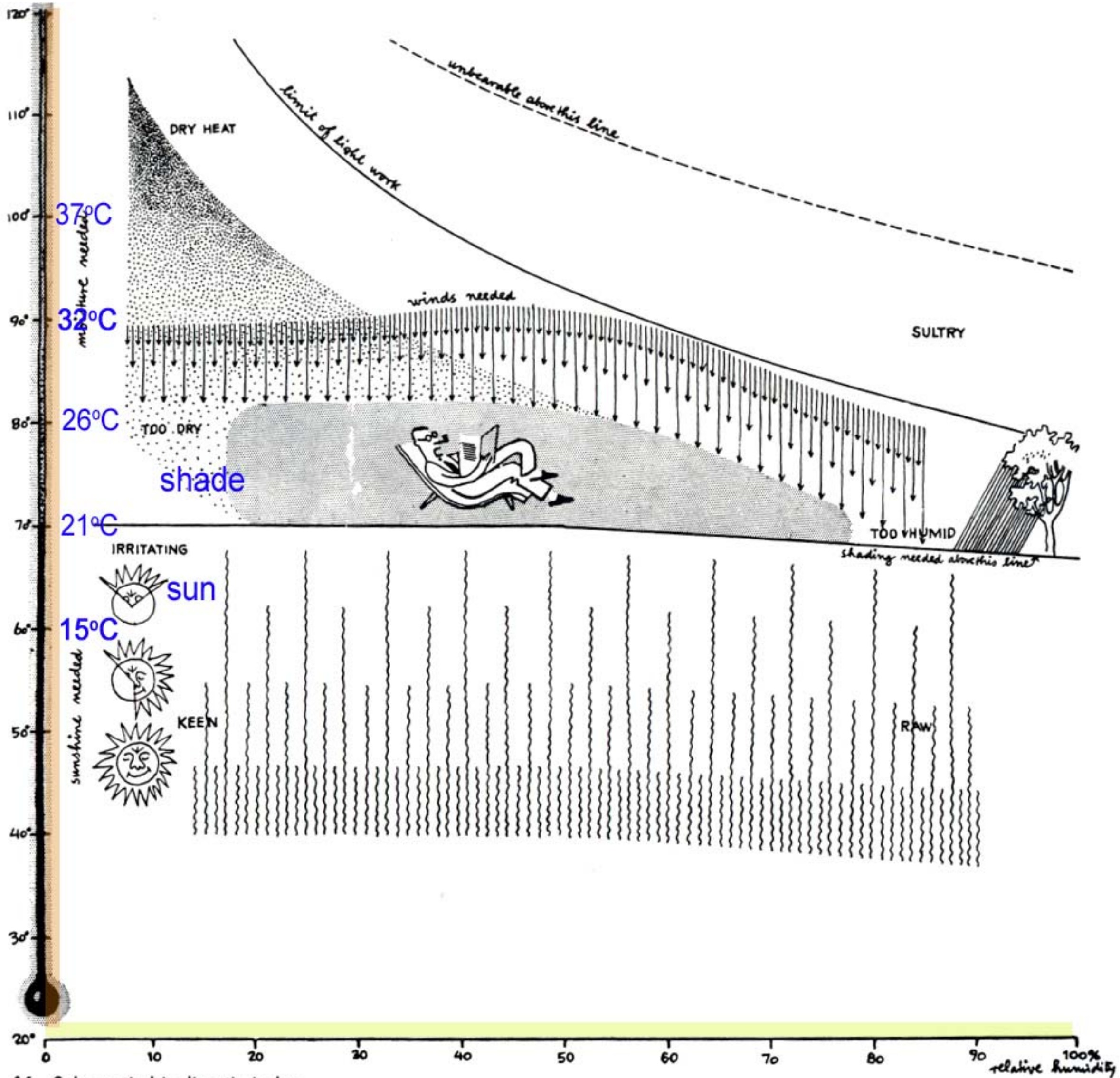
* Analyze the terrain of the site for its influence on air movement, solar access and *overshadowing*.
(more on this in a later lecture)



The "comfort zone": our goal for both *interior* and *exterior* spaces



SWL

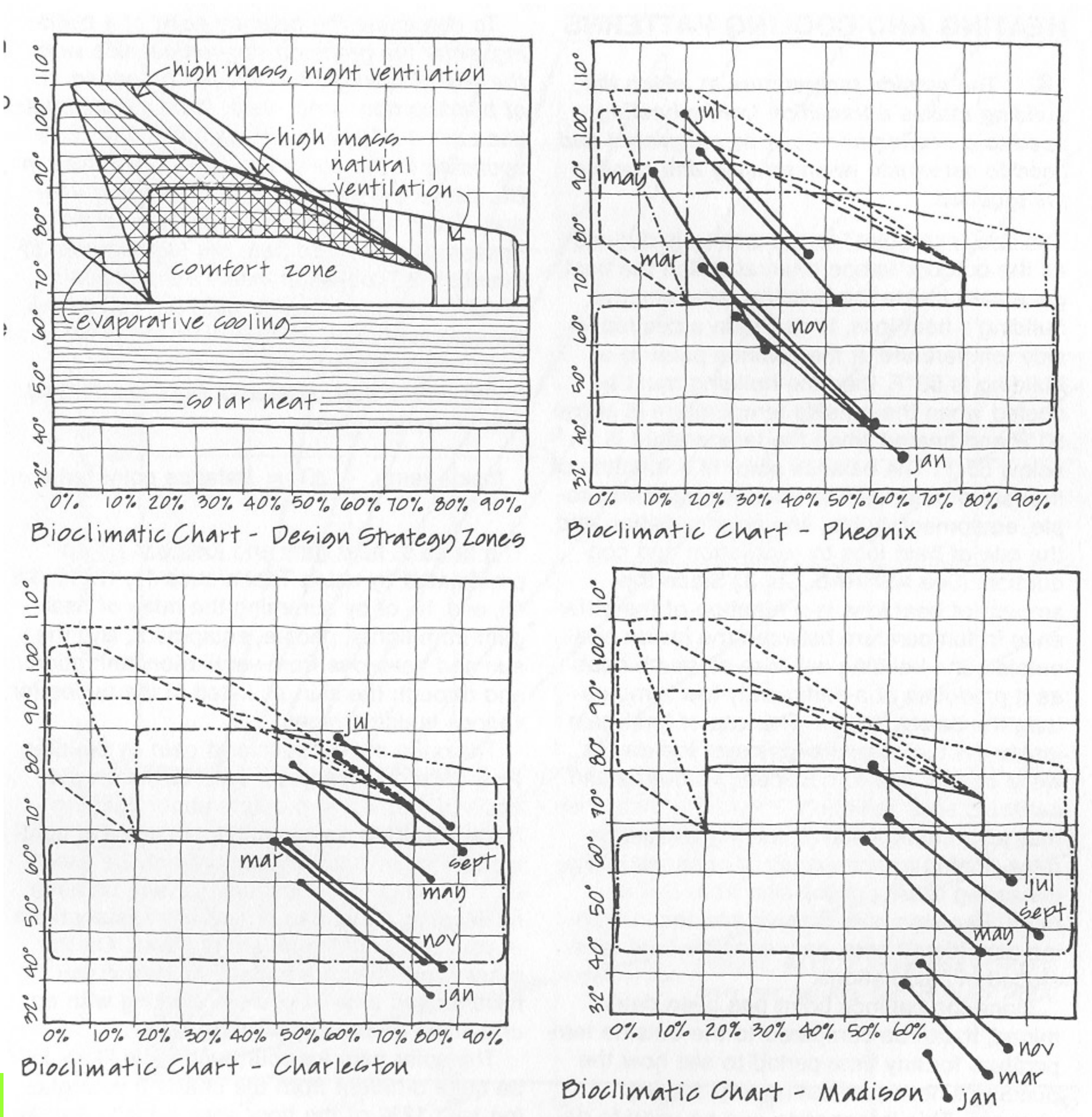


46. Schematic bioclimatic index.

From "Design with Climate", Olgyay, 1963

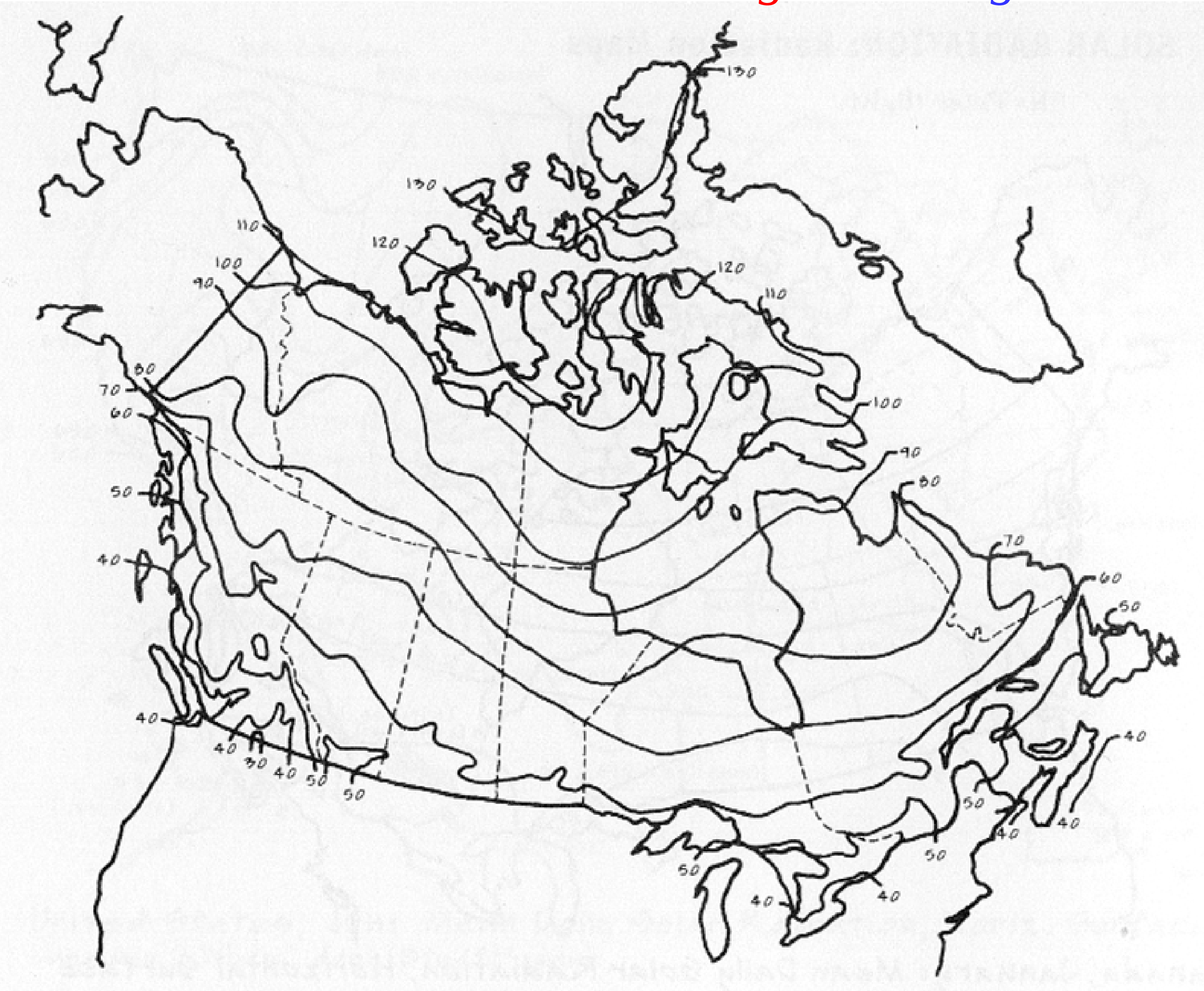
DWC

The “comfort zone”: different response to different climates



From “Sun, Wind and Light ”, Brown, 1985

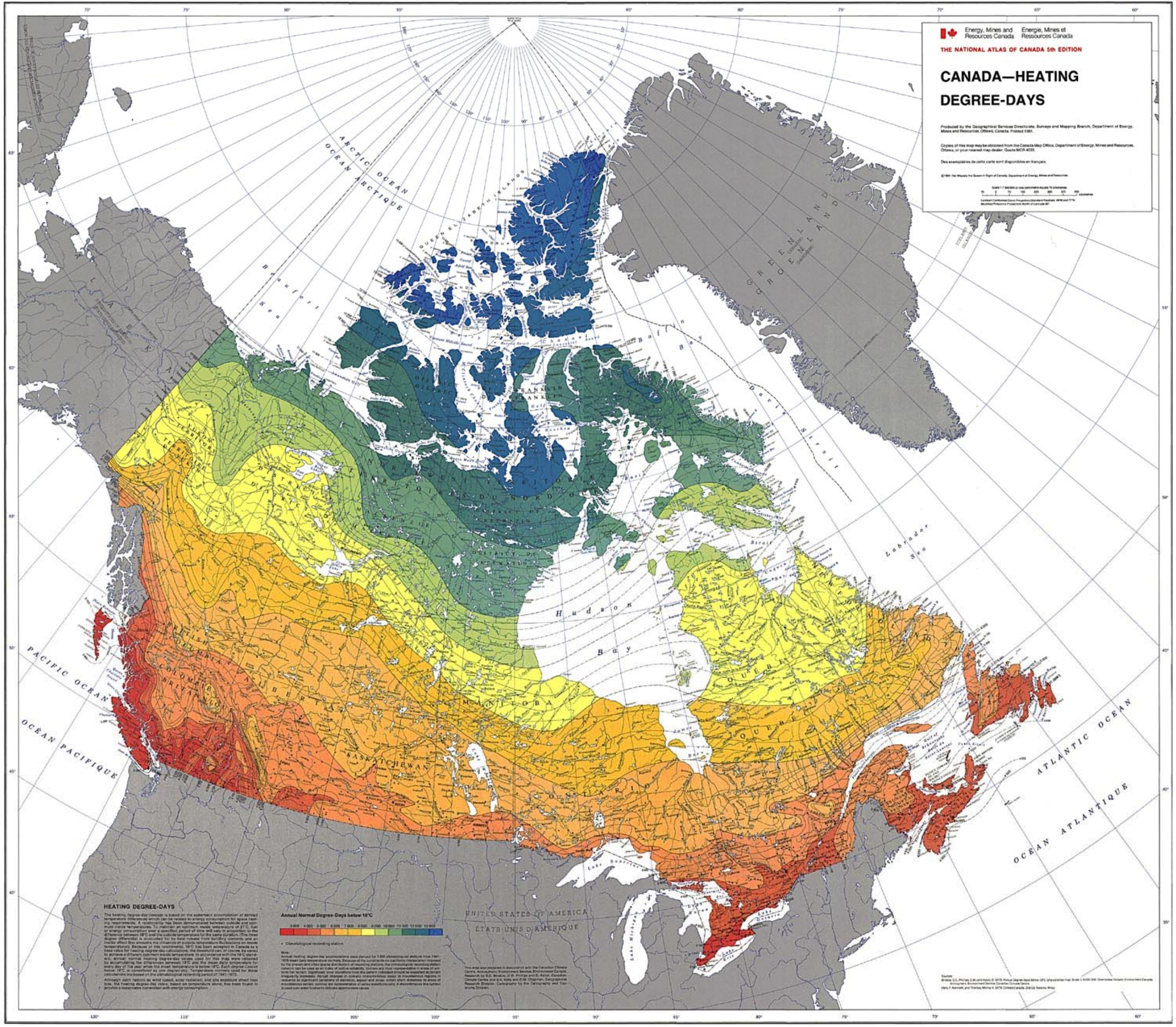
Determine if the climate is *heating* or *cooling* dominated:



Annual Heating Degree Days for Canada, base 18 °C
Source: based on Environment Canada (1988).

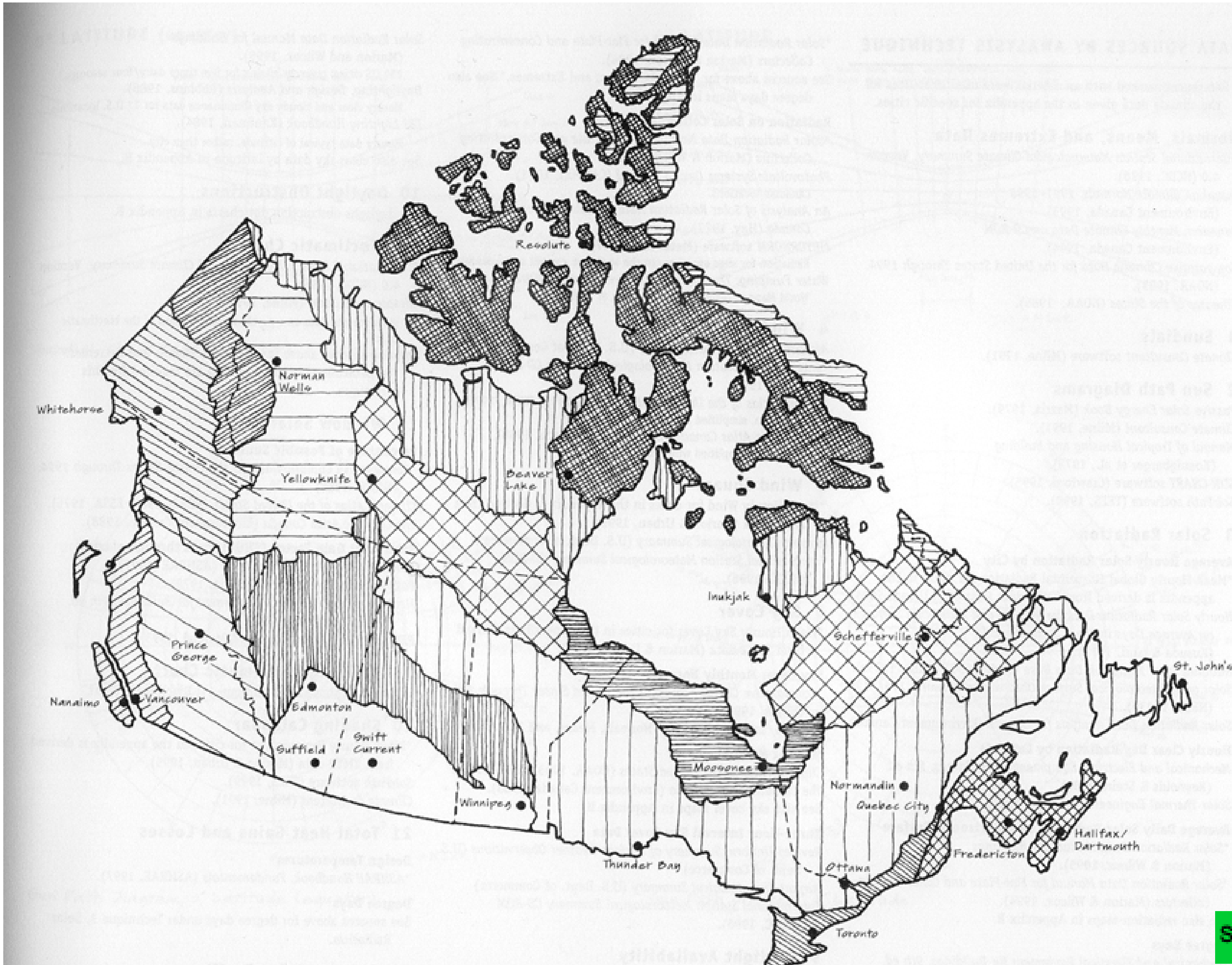
…this will set out your primary strategy

SWL



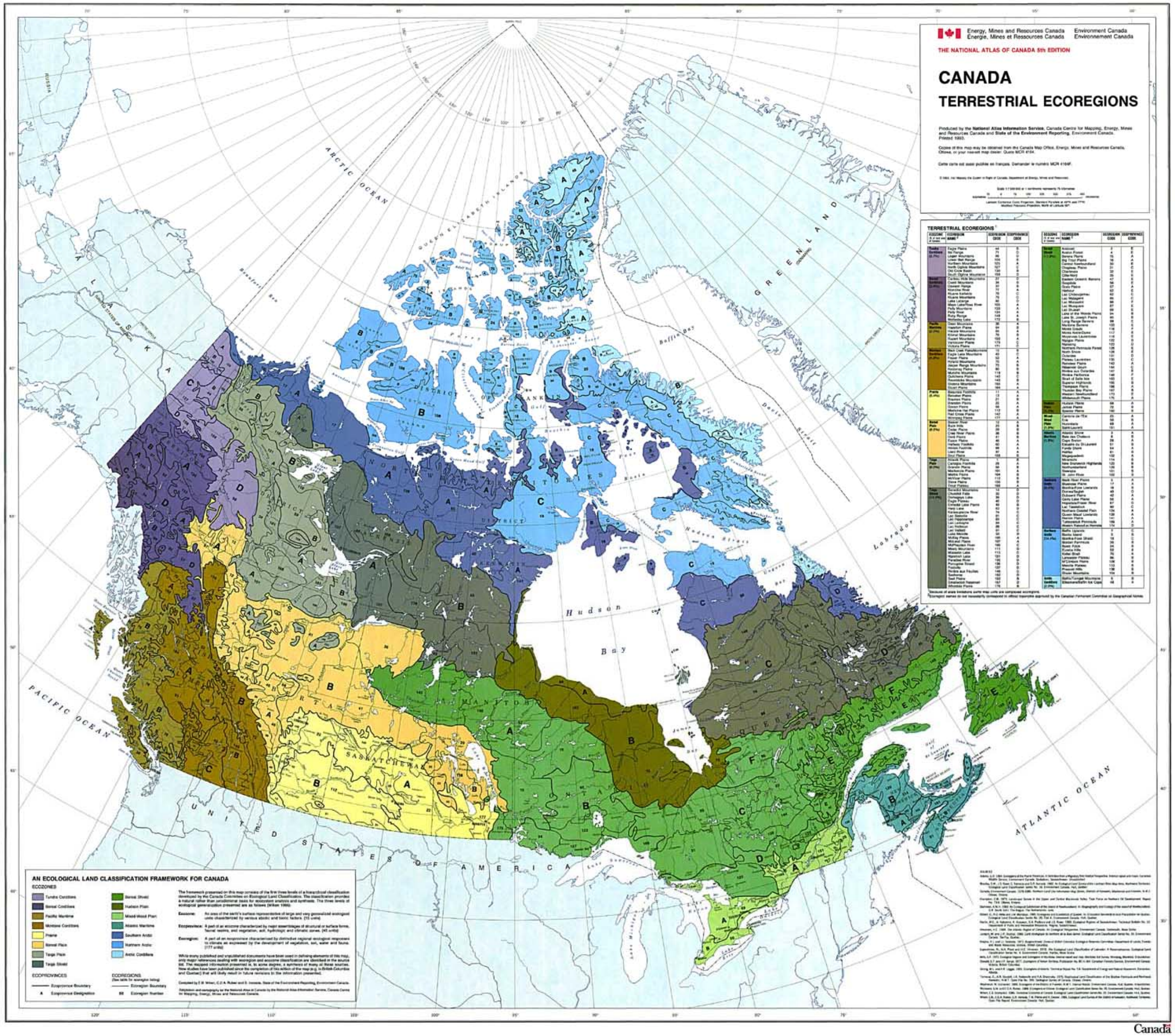
Shows the annual sum of heating degree days (an indicator of building heating needs). Data for period 1941 to 1970.

Understand local regional differences and similarities so you can learn from other building projects in nearby areas:



Terrestrial Ecozones of Canada based on Environment Canada (1995).

SWL



All of Canada shown in the first three levels of Environment Canada's hierarchical ecological land classification system: ecozones, then ecoprovinces and finally 177 ecoregions.

This will affect type choices of plant material that you can use.

Materials - Juxtaposition

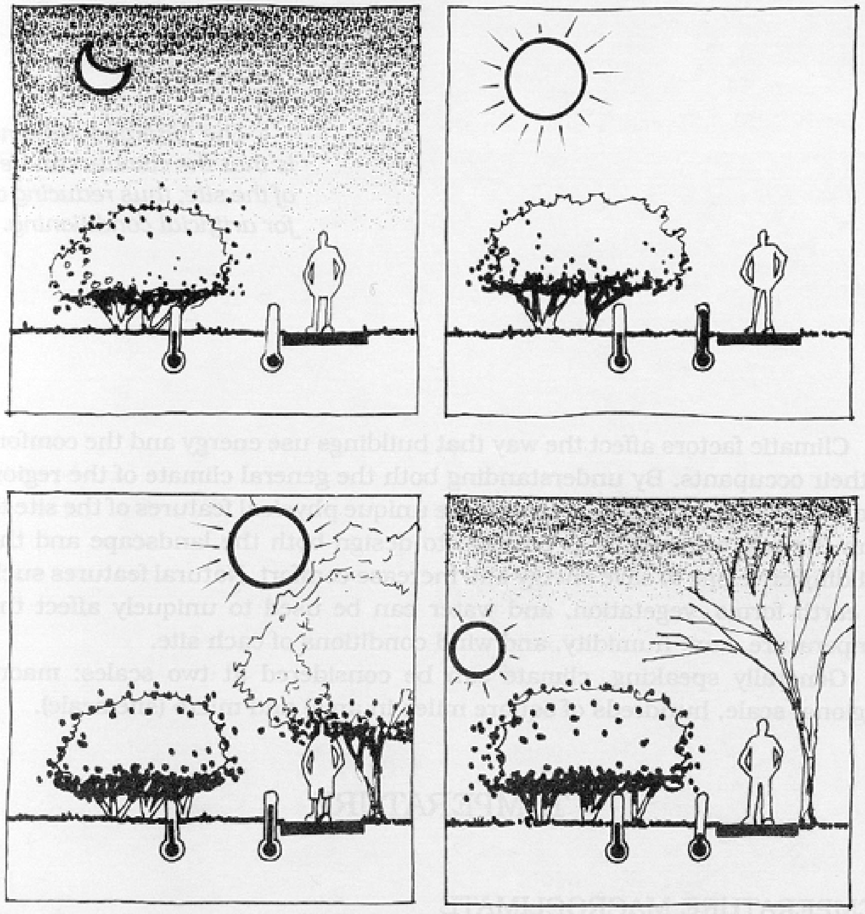
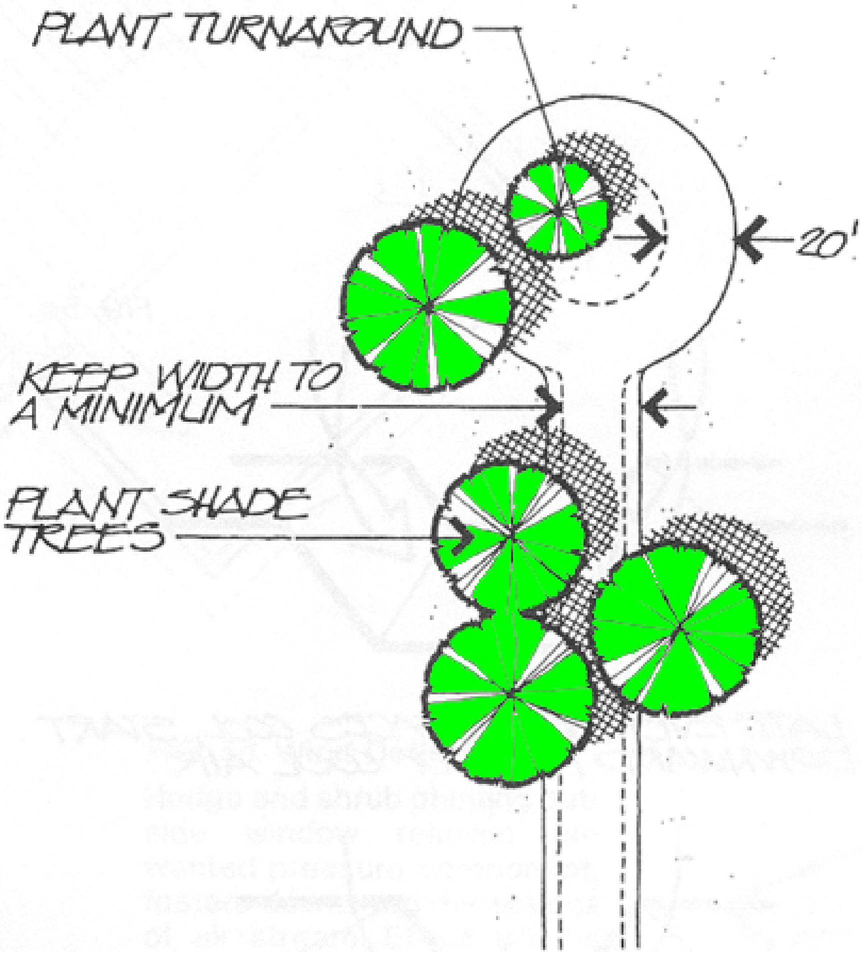


Figure 4.2: Comparison of the effects of plants and paving on ground temperatures: (a) seasonal variation, (b) daily variation. *(Reproduced from Robinette, 1977, by permission.)*

HCL

Microclimate talks about moderating your immediate environment by the placement of materials, trees, building orientation for sun and wind. *Relative position makes a difference.*



Site Planning Suggestions:

Keep paved area to a minimum—an 8ft. dia. turnaround with a 20 ft. ring road is recommended.

If spillover parking areas are required use a porous paving block instead of asphalt.

Plant shade trees to shade paving.

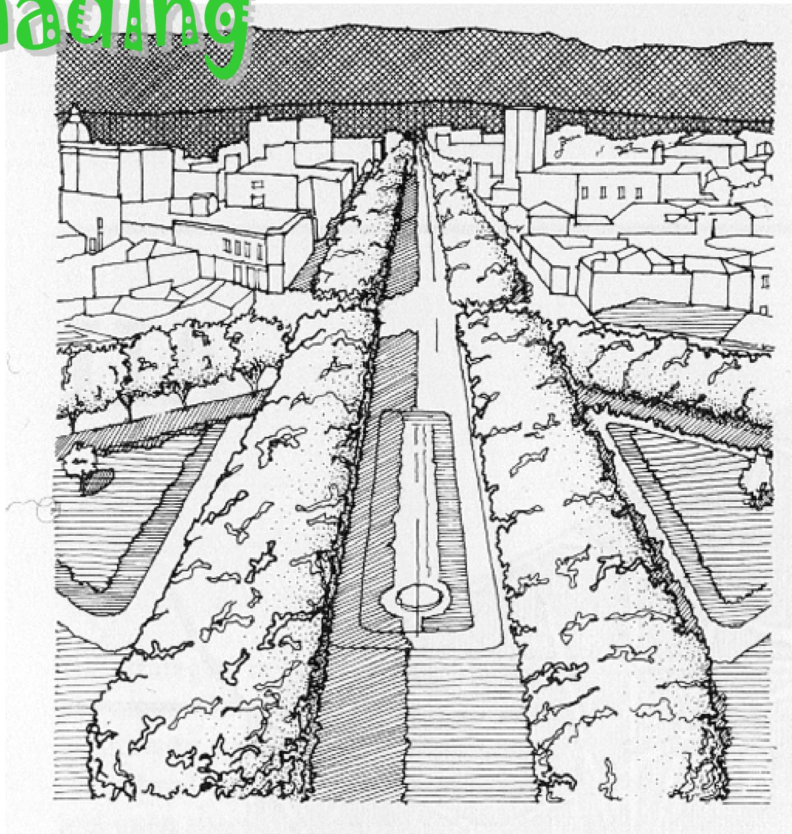
Use 18-20 ft. street width for large lot (34 acre or more) developments.

Use 26 ft. street width for 14 acre lots on cul-de-sacs and short loops.

Avoid 34-36 ft. street widths—these are never warranted in well planned new developments.

CBD

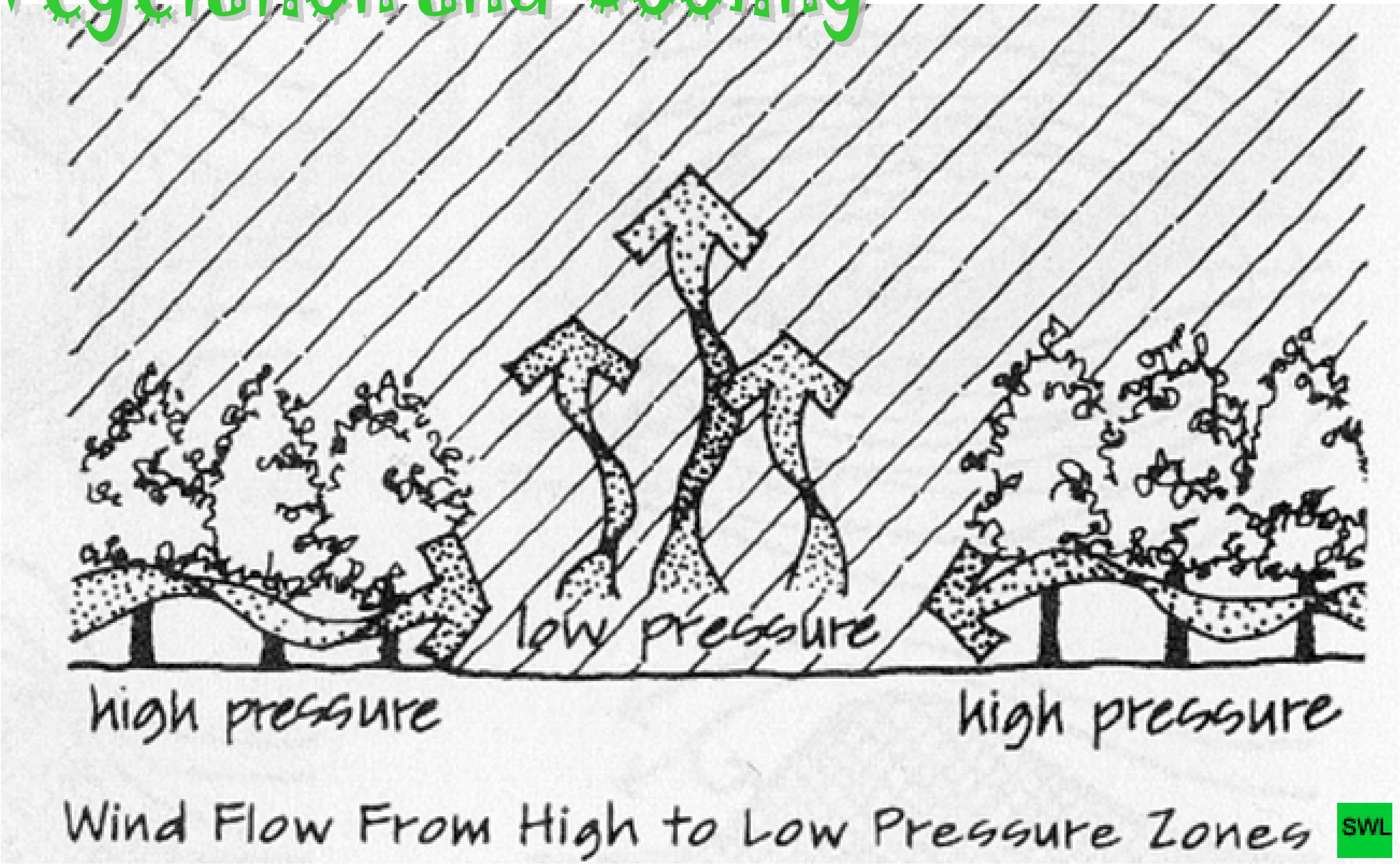
Vegetation and Shading



Shaded Boulevard, Belo Horizonte, Brazil

Shaded streets, parks and green roofs all can be used to alleviate the urban heat island effect.

Vegetation and Cooling



Tree cover and green areas also affect wind flow patterns.

Clear vs. Cloudy

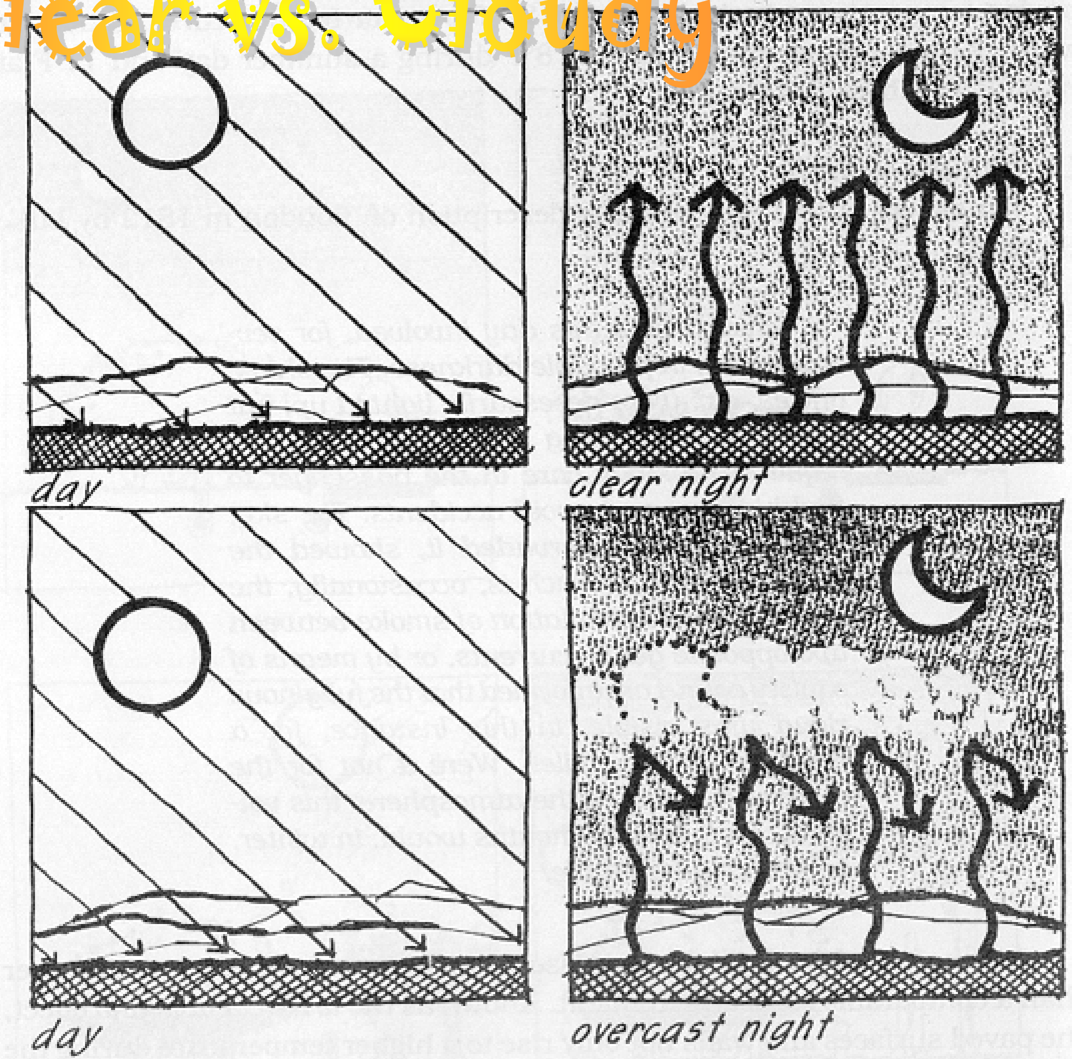


Figure 4.5: Effect of humidity and cloud cover on nocturnal radiation cooling. *(Redrawn from Robinette, 1977, by permission.)*

HCL

Clear night skies can allow summer heat and humidity to be dispersed to the sky for natural cooling.

Cloud cover can keep heat and humidity trapped around building environments.

Vegetation and Wind

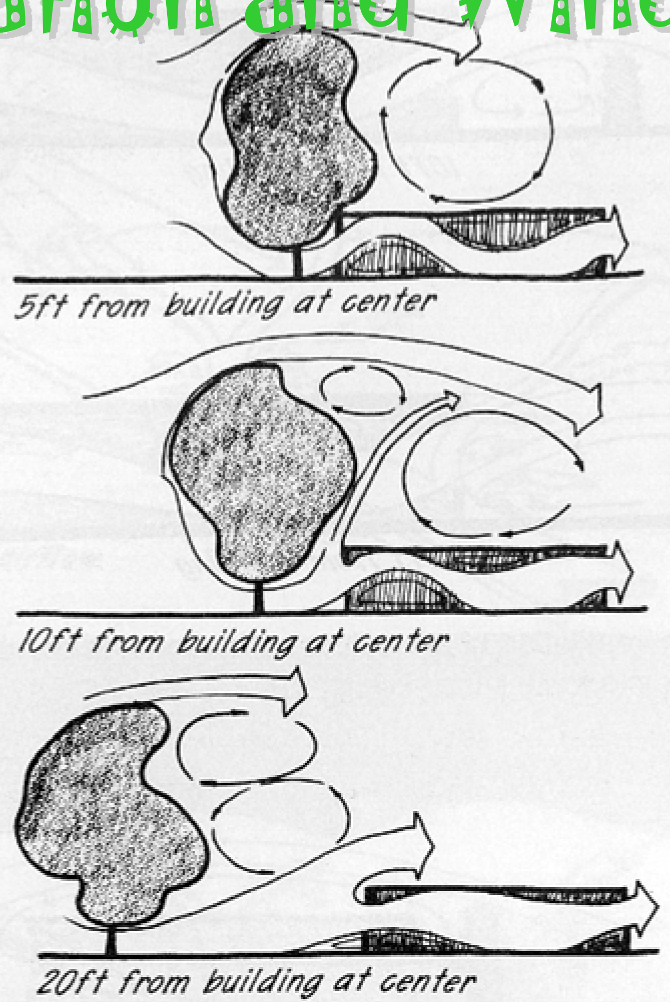


Figure 4.17: Effect on ventilation of a 30-ft tree on the windward side at different distances. *(After White, 1953.)*

HCL

Vegetation can be used to shade and cool buildings from outside. It makes a difference how close the tree is to the house -- for both wind and shade.

Vegetation and Wind

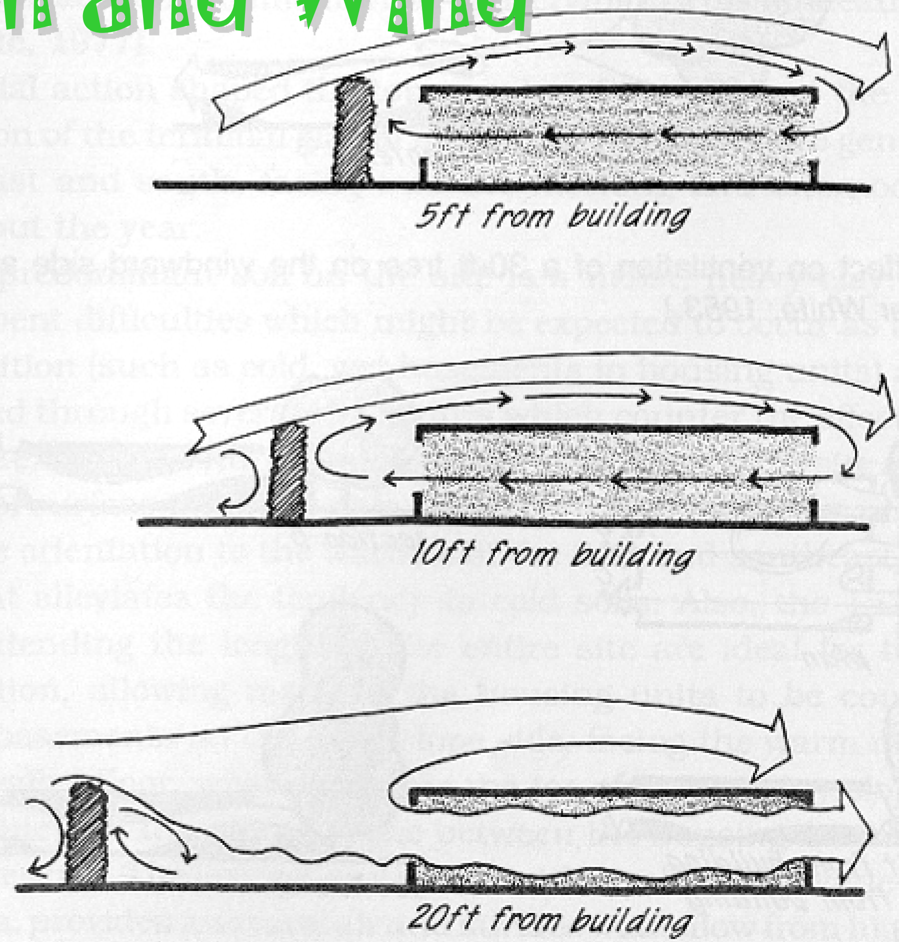
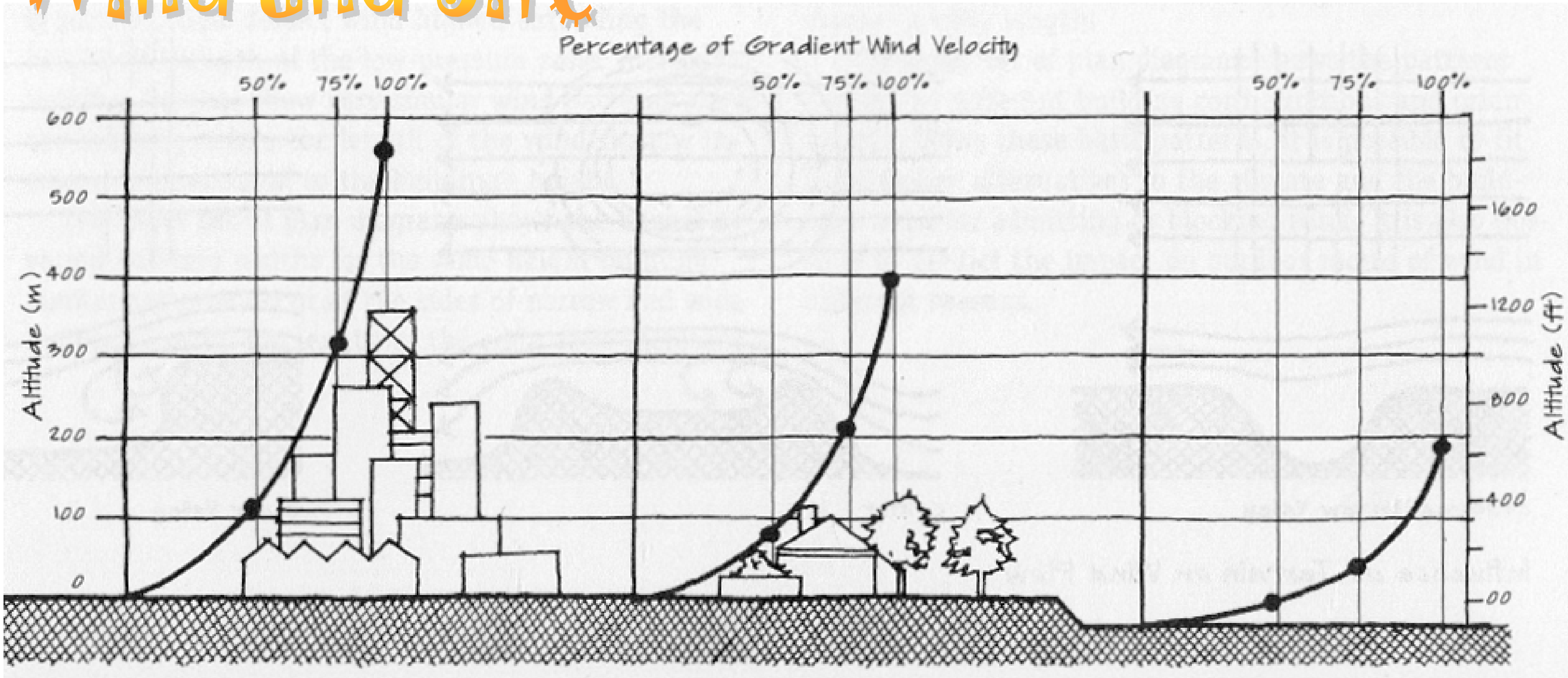


Figure 4.16: Effect on ventilation of a high hedge located parallel to the windward windows at different distances. *(After White, 1953.)*

Wind and Site



Effect of Terrain on Wind Velocity Profiles

SWL

On the opposite side, building density elevates wind speeds -- which may cool in the summer, but cause severe problems in the winter.

Wind and Site

Vegetation can be used to create wind breaks around highly exposed buildings. This creates a more sheltered situation behind the "fence" or "hedge".

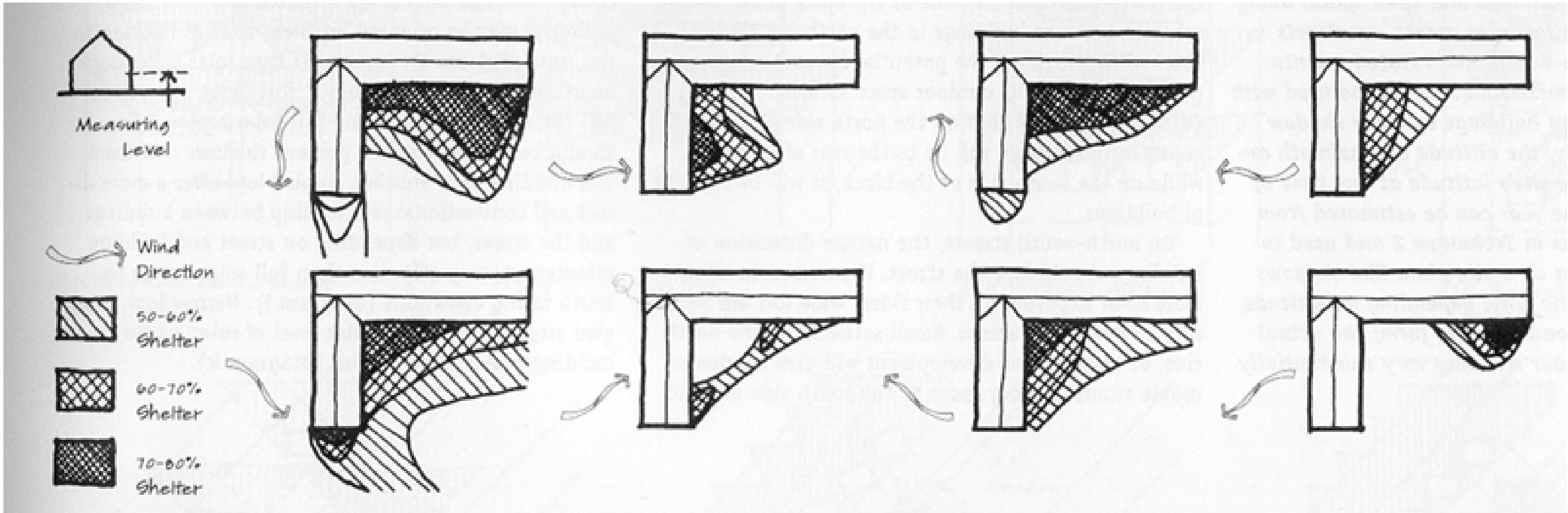

Vegetation Wind Breaks for Farms in Shimane Prefecture, Japan

SWL

Windscreen around a house on the road to Waterton Park in Alberta. Cold climate. Hilltop location. Windy site.

Wanted the view...

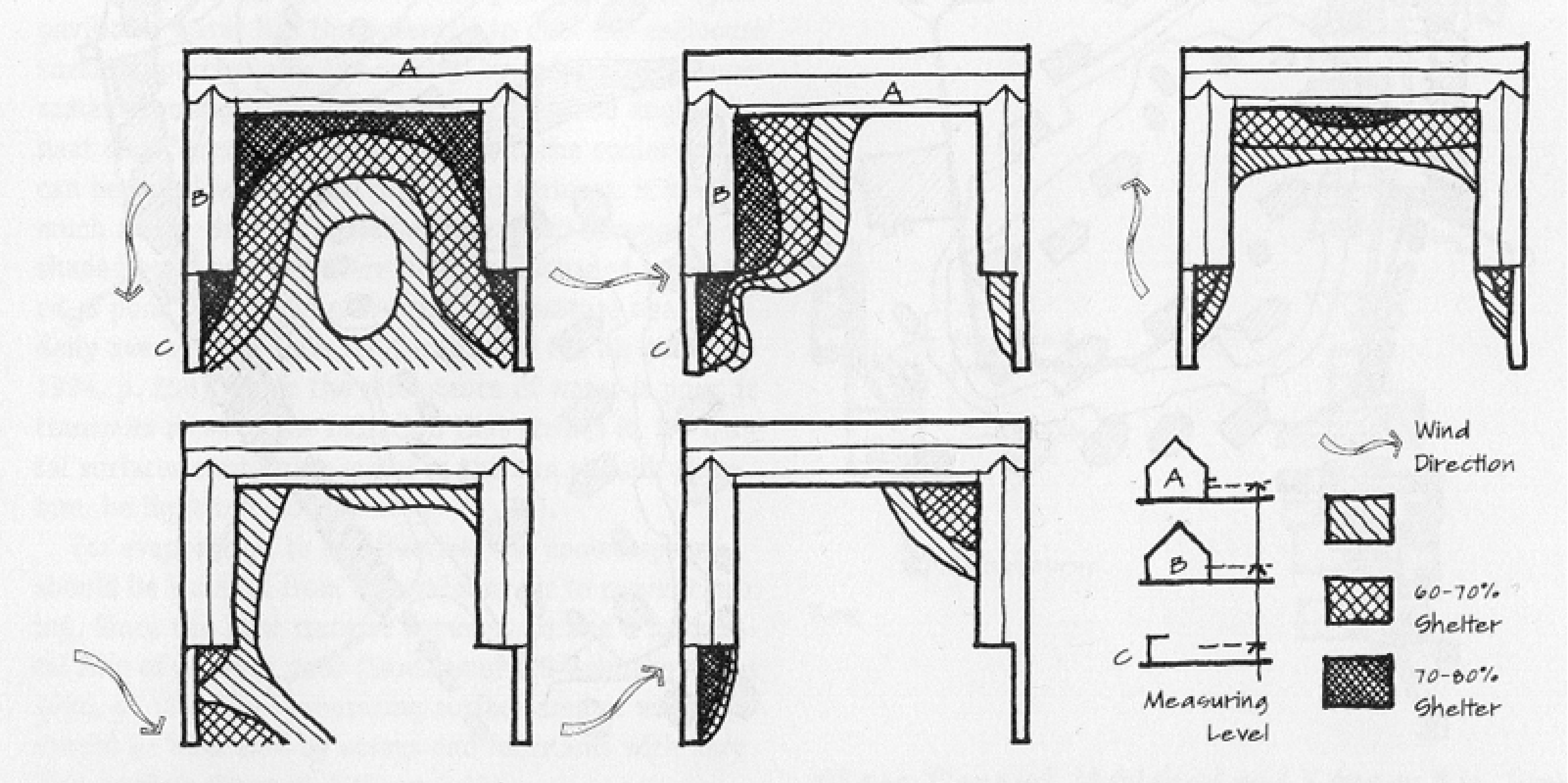
Wind and Site



Wind Shelter Patterns in L-Shaped and Closed Courtyard Organizations for Different Wind Directions
Adapted from Jensen & Frank (1963, pp. 56-67).

Buildings themselves can adopt different planimetric patterns as a way to block wind and create sheltered zones. This can be coupled with solar orientation to create very warm protected zones.

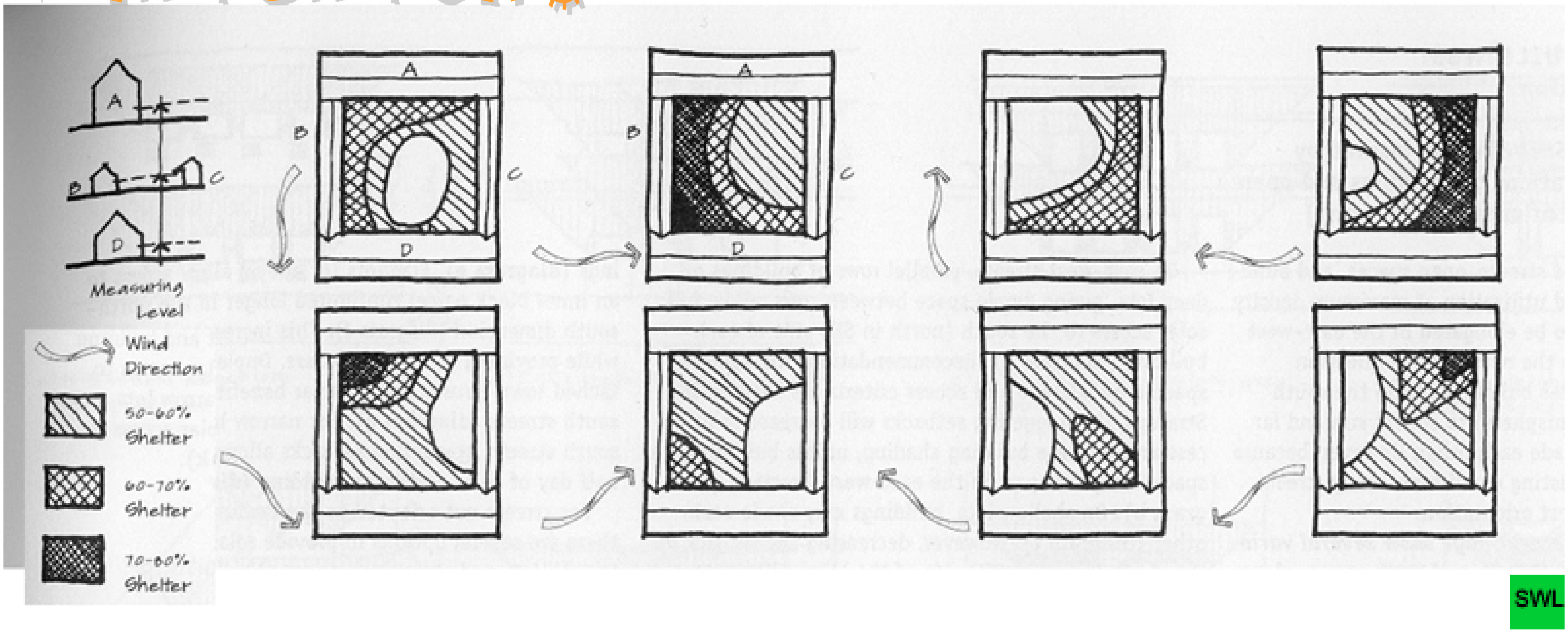
Wind and Site



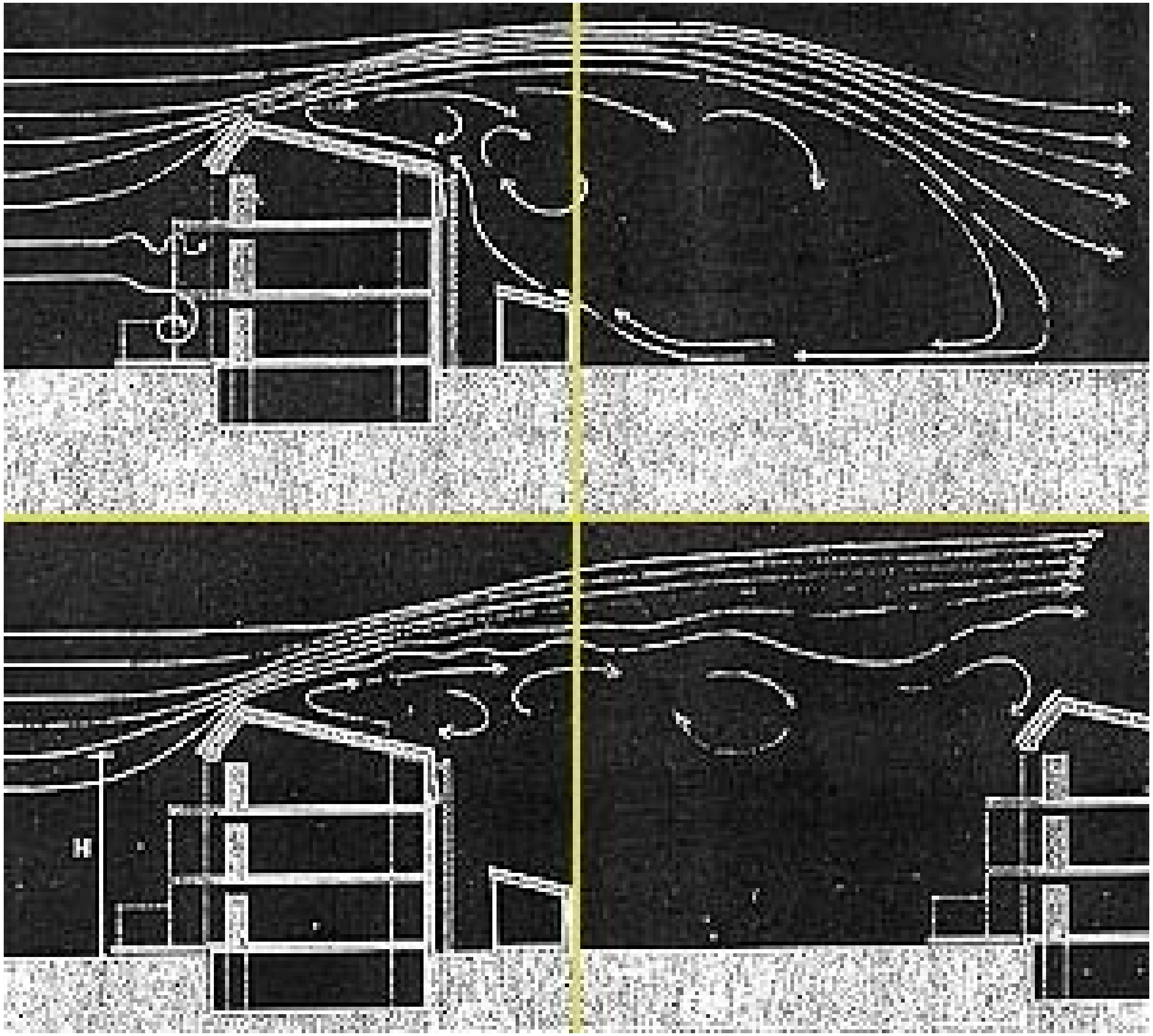
Wind Shelter Patterns in U-Shaped Organizations for Different Wind Directions

A U shaped building pattern can be used to create wind protection from two directions.

Wind and Site



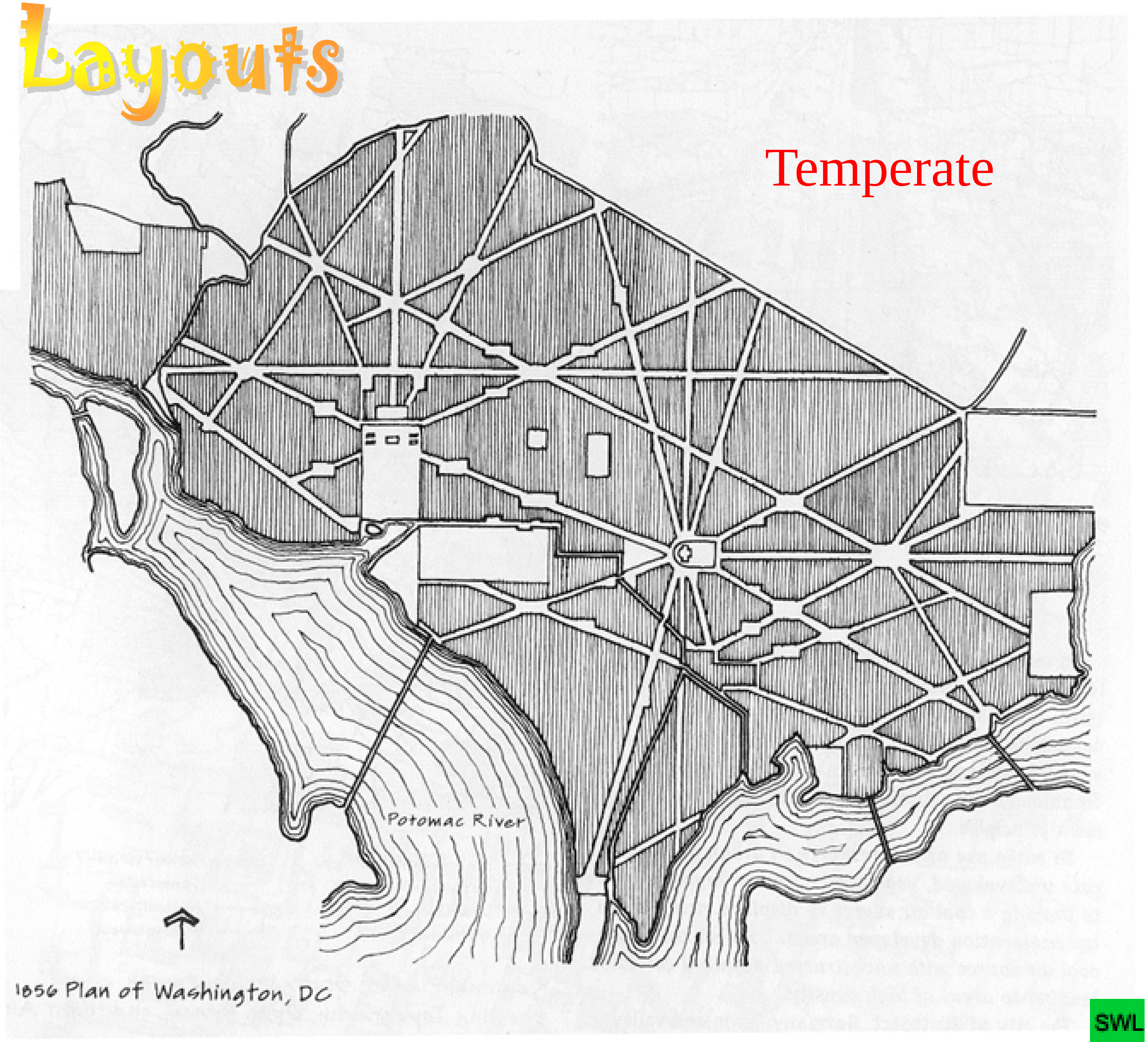
Courtyard patterns can create wind direction -- but the height to width ratio of the court must be designed also for the solar latitude and climate type. Low winter sun angles in northern latitudes do not work well with courtyard shapes.



Distance between buildings affects the effectiveness of breezes. One building can easily block natural ventilation for the one behind.

Street Layouts

The street layouts of cities, with the introduction of wide avenues, were designed to allow air to flow through the city.



Temperate

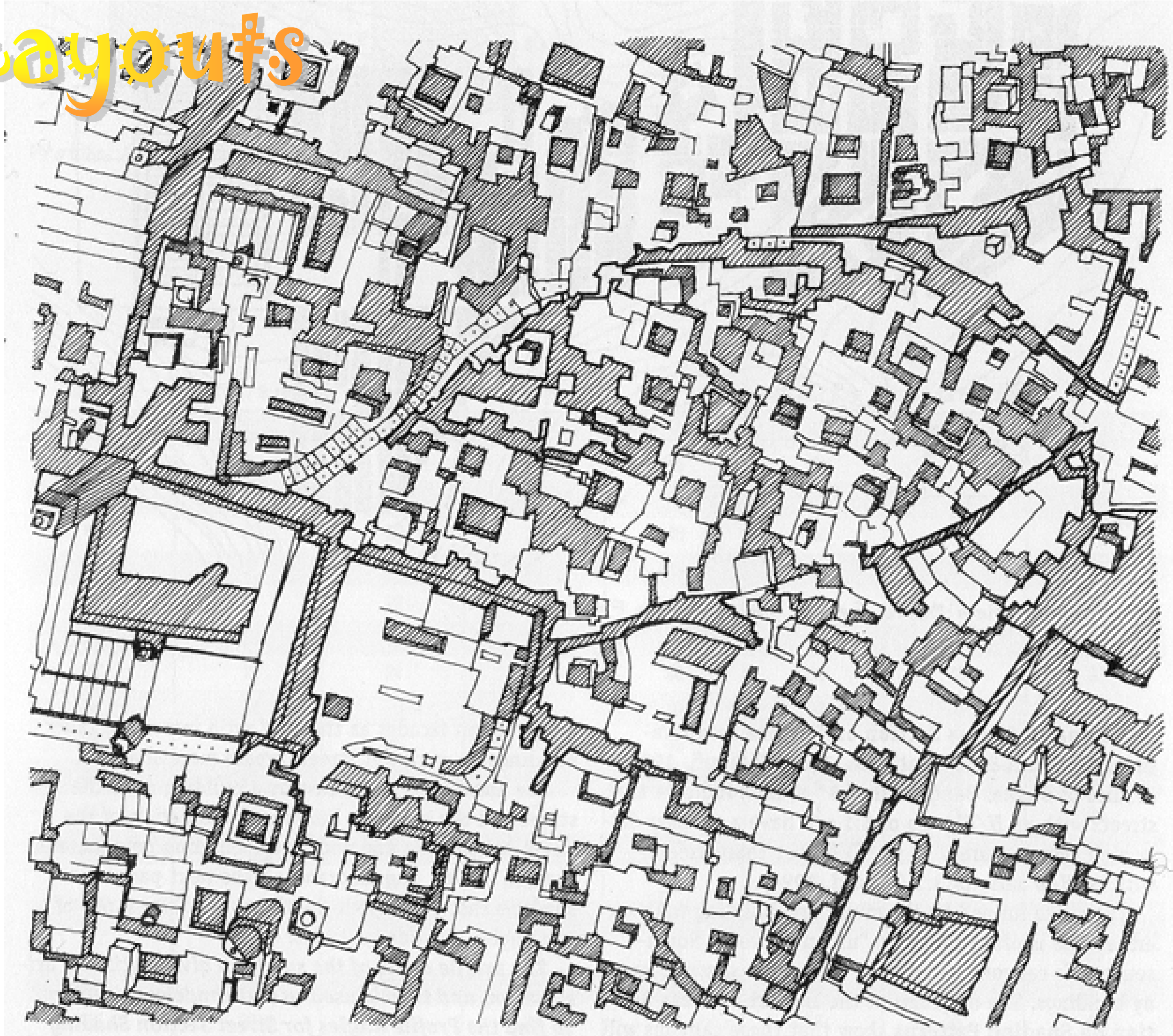
SWL

This is a thermally imaged map of Washington, D.C. showing its summer temperatures. Red is hot. Purple is cool.

The Washington “Mall” – large green space + water element.

Street Layouts

In hot arid climates where wind/ventilation is *not desired*, city layouts are very dense and work with overshadowing to create coolth.



Aerial View of Tunis, Tunisia

Hot-Arid

SWL

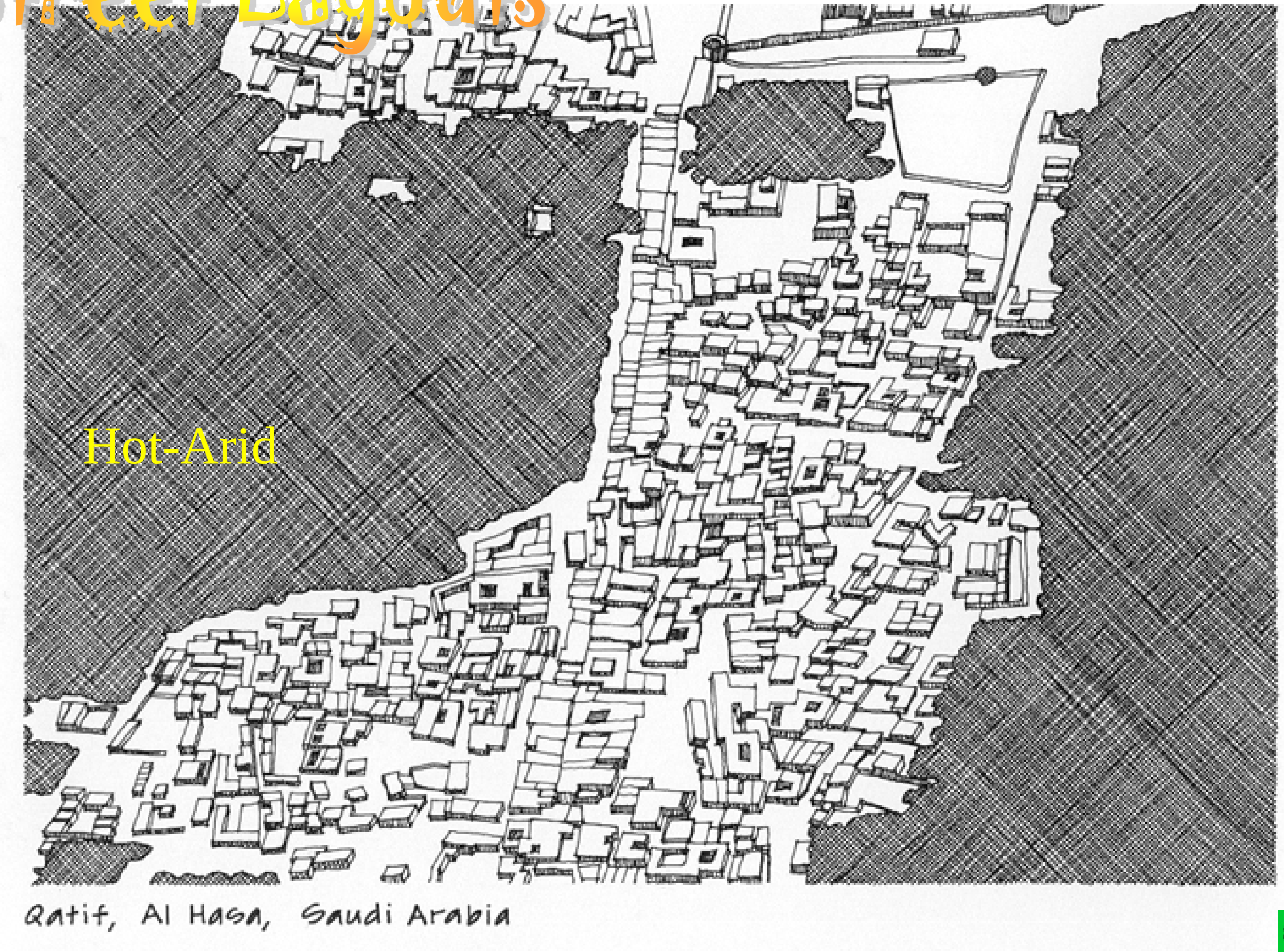
Street Layouts

Hot-Arid

SWL

In these urban layouts it is desired NOT to have solar access to the courtyards in order to avoid heating the space.

Street Layouts



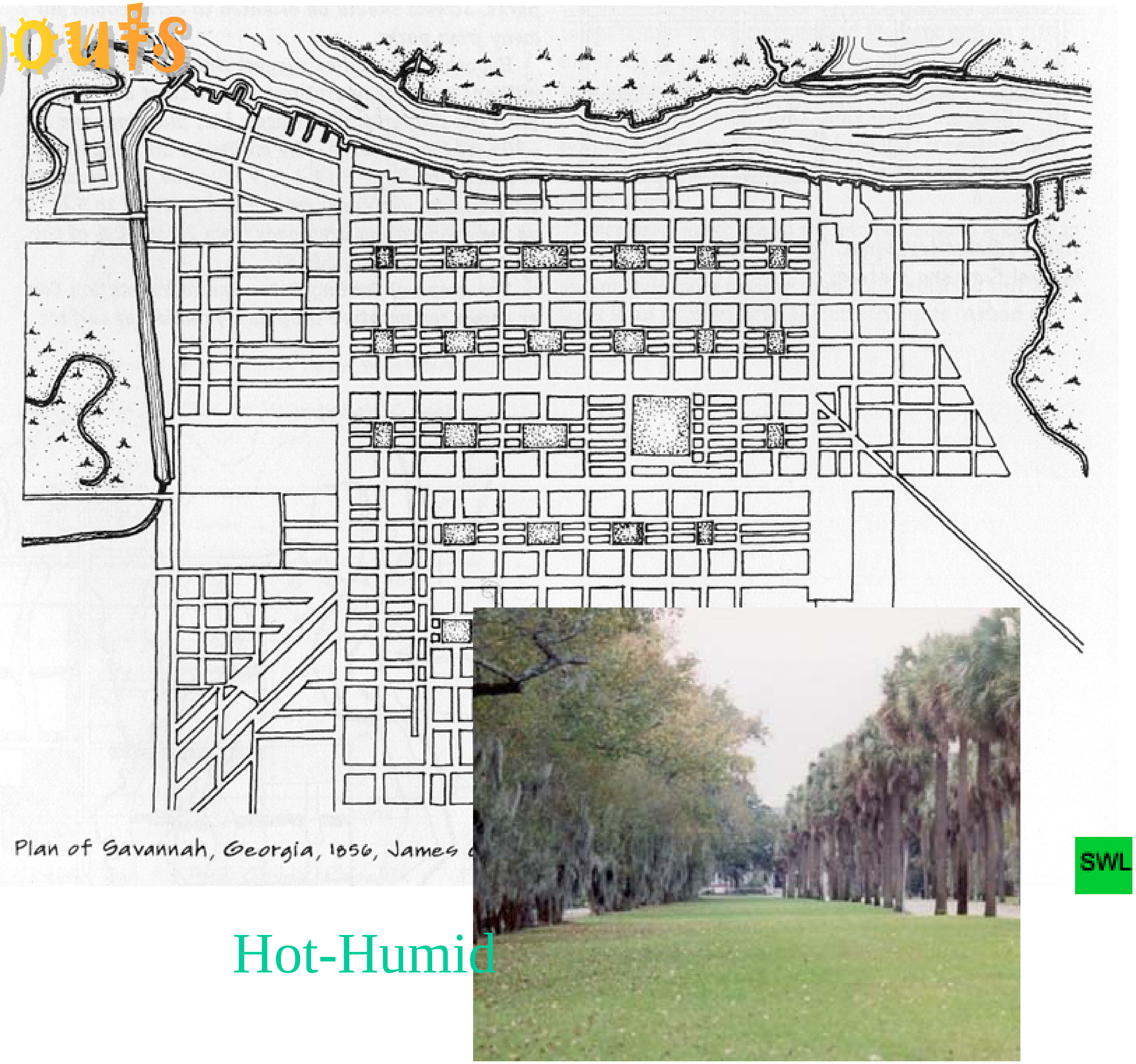
Street Layouts

In hot humid climates a very dispersed layout is desired to maximize the ability of any available breezes to cool the town and its buildings at all times.

Hot-Humid

Street Layouts

Savannah uses a combination of regular streets and vegetated squares to help keep the city environment cool.

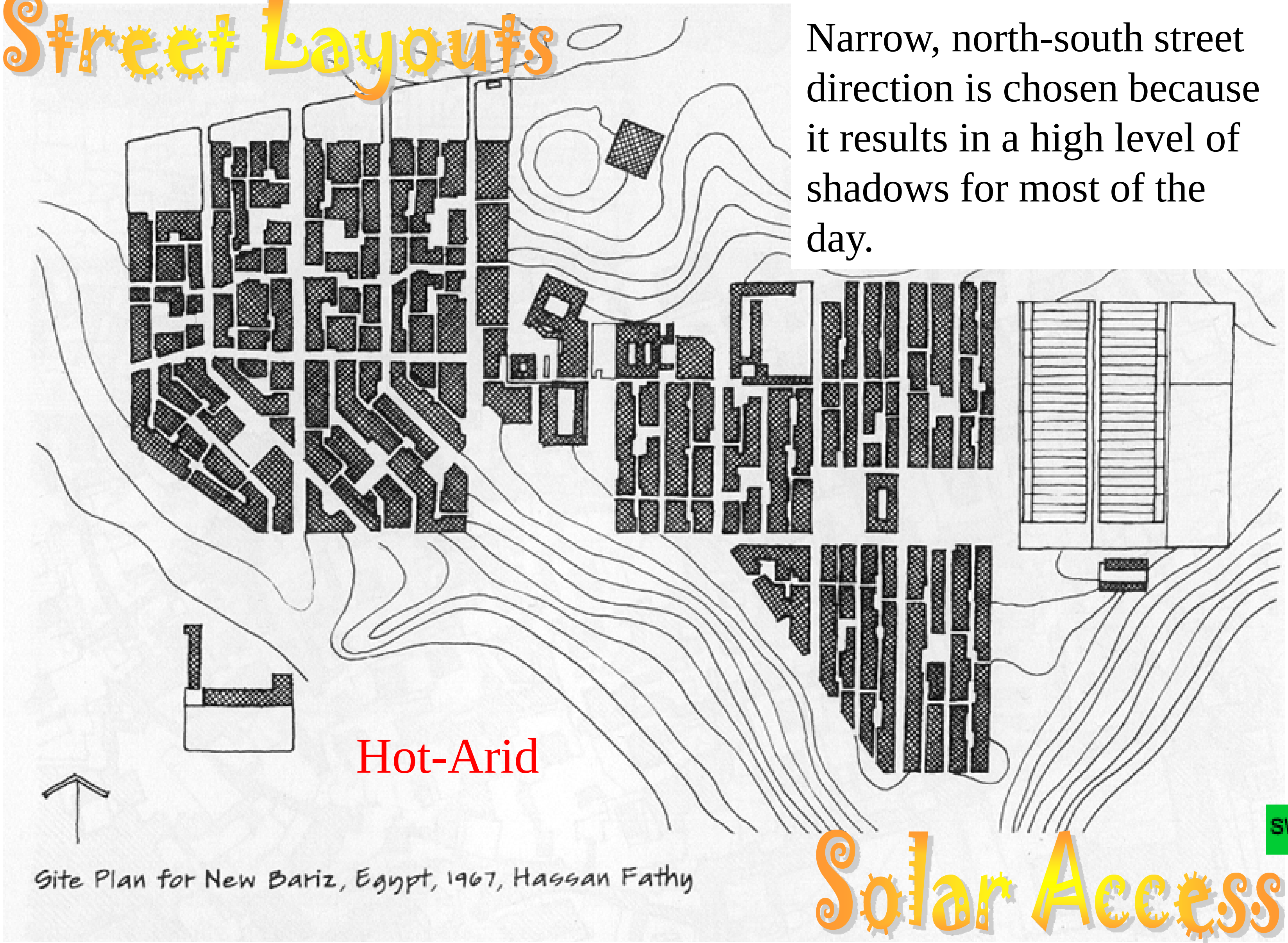


Hot-Humid

SWL

Savannah, Georgia

Street Layouts



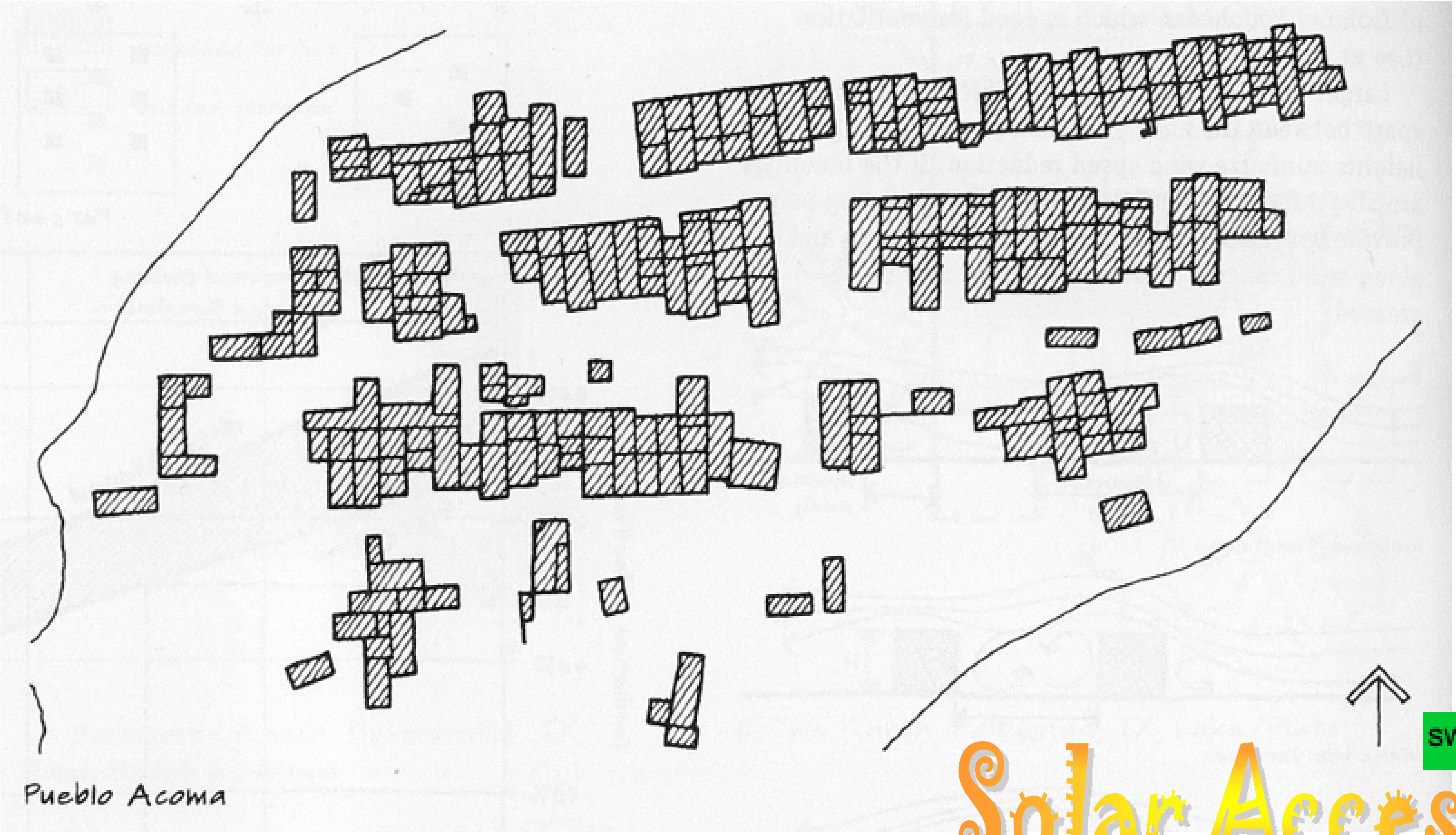
Narrow, north-south street direction is chosen because it results in a high level of shadows for most of the day.

Hot-Arid

Solar Access

SWL

Street Layouts

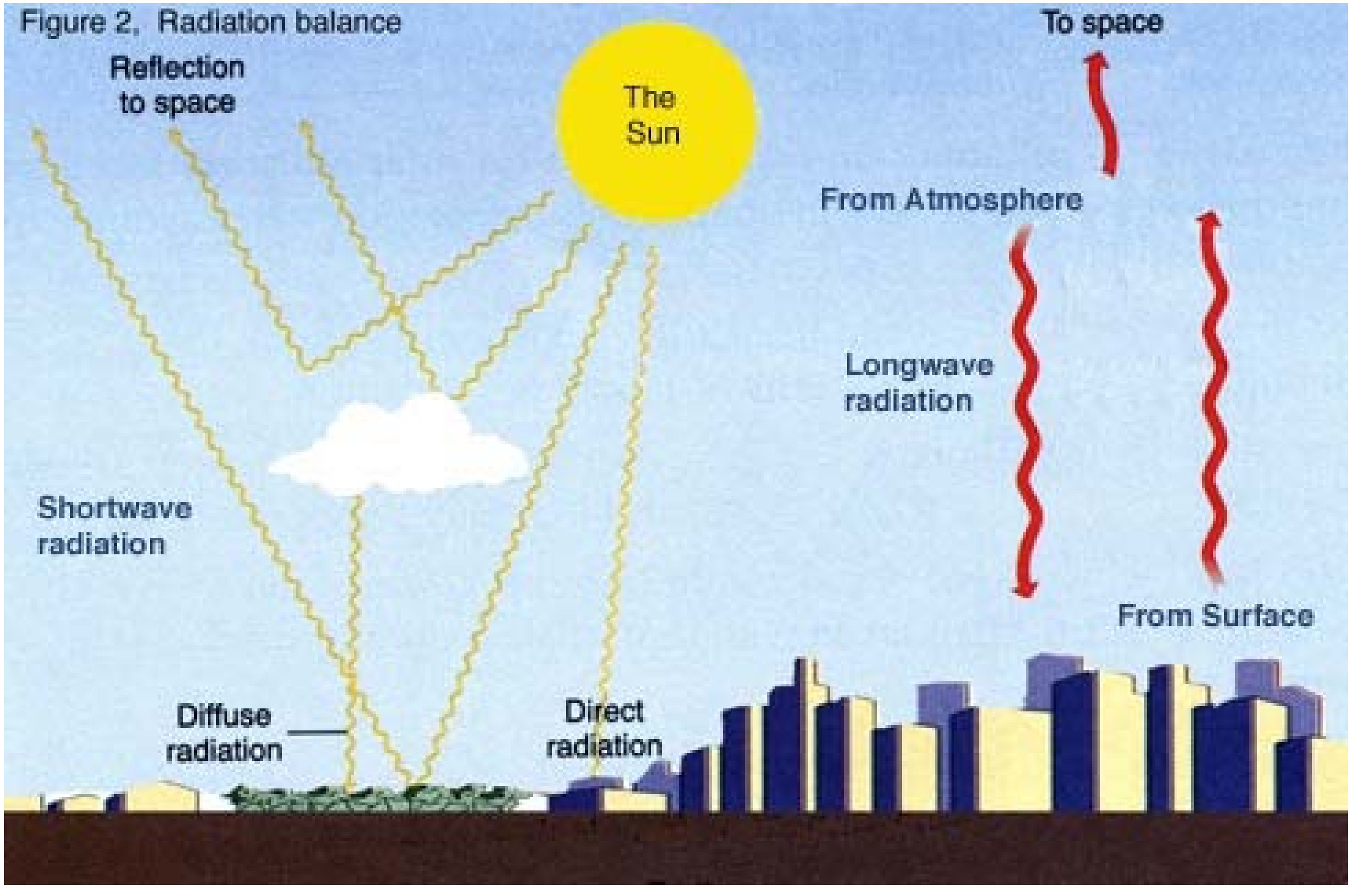


Solar Access

SWL

Easiest to design for solar orientation is east west streets IF there is adequate space between buildings in the north-south direction - *more later*.

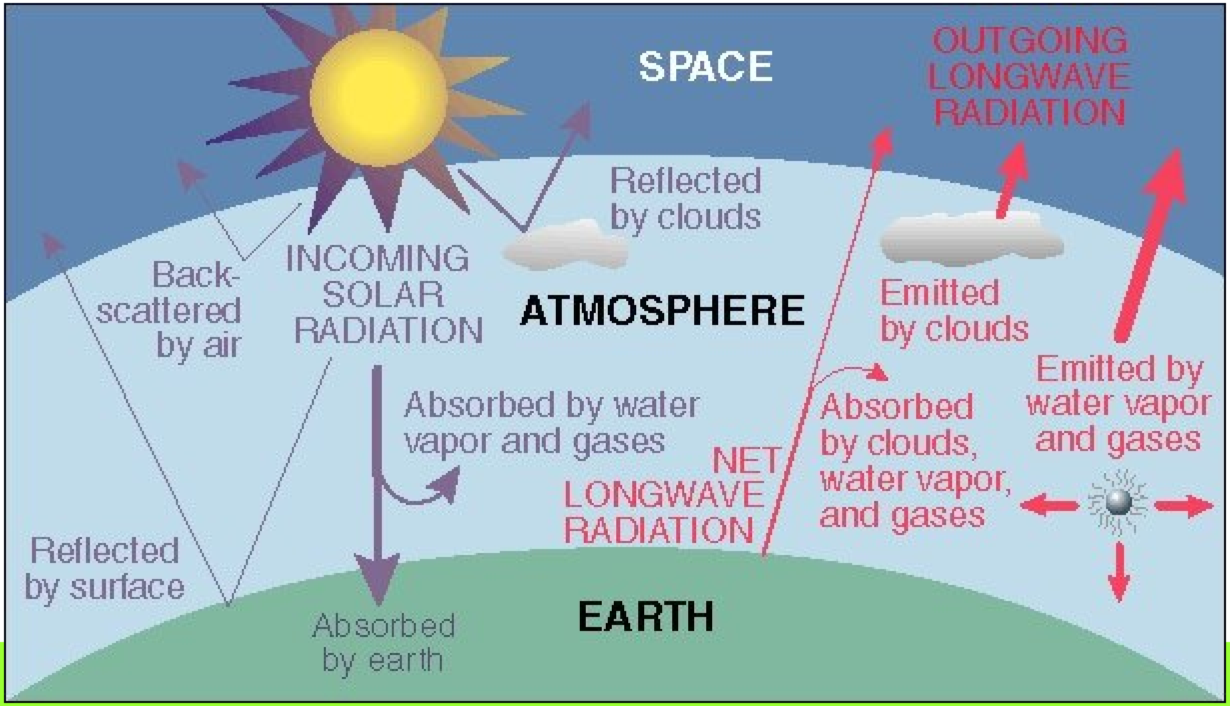
Solar Access



The sun affects the local climate in different ways - characterized by “direct radiation” vs. “diffuse radiation”, and “shortwave” vs. “longwave” radiation.

Shortwave radiation: In meteorology, a term used loosely to distinguish radiation in the visible and near-visible portions of the electromagnetic spectrum (roughly 0.4 to 4.0 µm in wavelength) from longwave (terrestrial) radiation. *(you can SEE this)*

Longwave radiation: Heat radiation with wavelengths greater 4 µm. Both the Earth and the atmosphere emit longwave radiation — how much each emits is a function of temperature. At the Earth's surface, emission is simply a function of surface temperature: the higher it is, the more longwave radiation is emitted. *(you can only FEEL this)*



Solar Access

Figure 3.17: Acoma pueblo, New Mexico, looking northeast. *(Reproduced from Knowles, 1974, by permission.)*

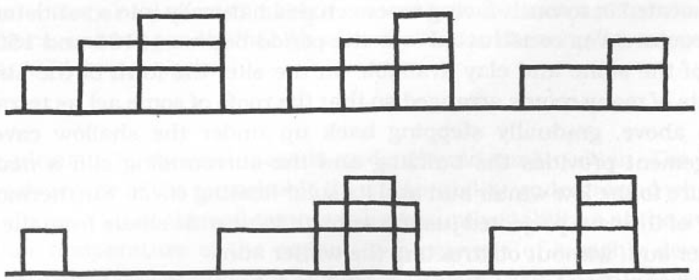


Figure 3.18: Acoma Pueblo, New Mexico. Typical sections show the critical spacing between rows of three- and two-story houses to ensure solar access. *(Redrawn from Knowles, 1974, by permission.)*

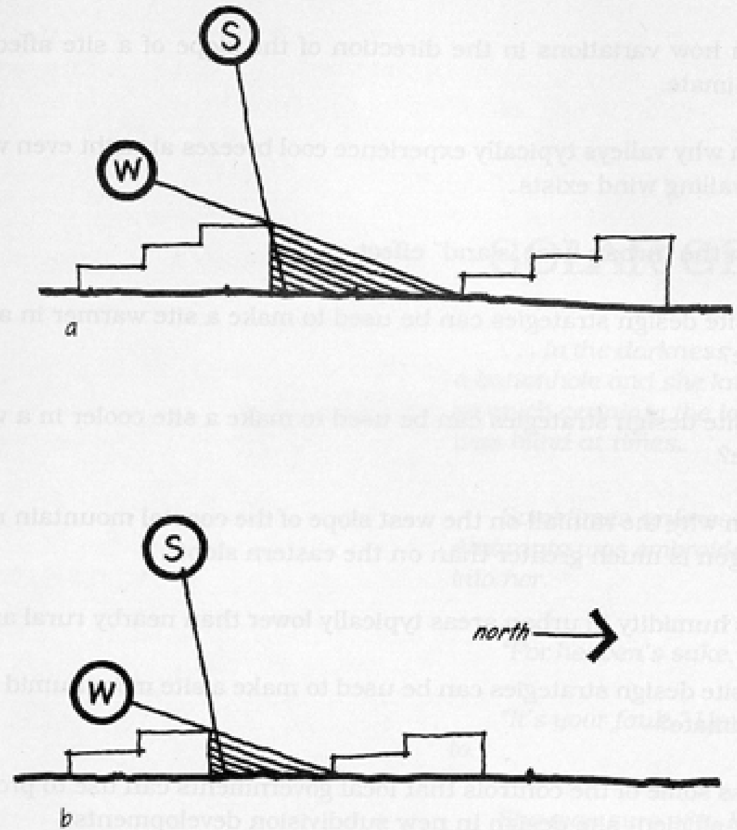
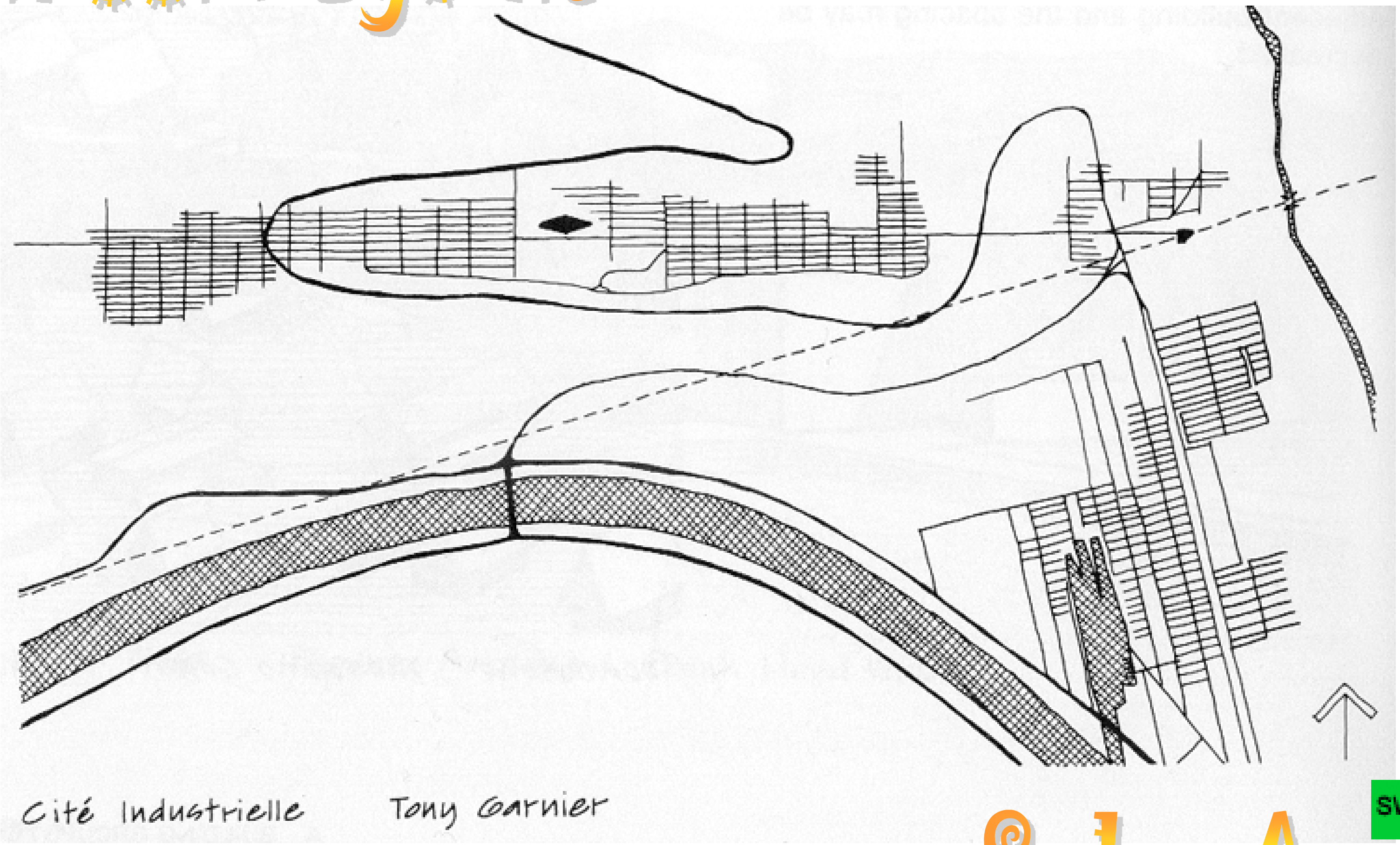


Figure 4.27: Acoma Pueblo, New Mexico. Typical sections show the critical spacing between rows of (a) three- and (b) two-story houses to ensure solar access. *(Redrawn from Knowles, 1974, by permission.)*

HCL

Depending on the site, climate, time of year, we need to decide if we WANT or DON'T WANT solar heat on and around our buildings.

Street Layouts

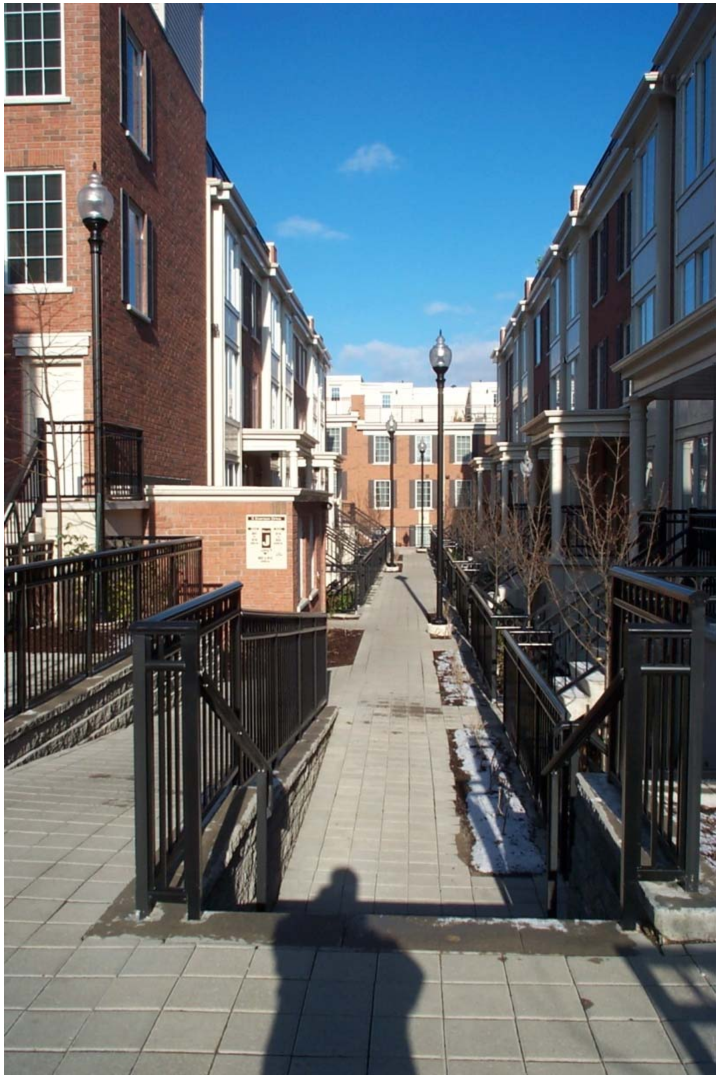


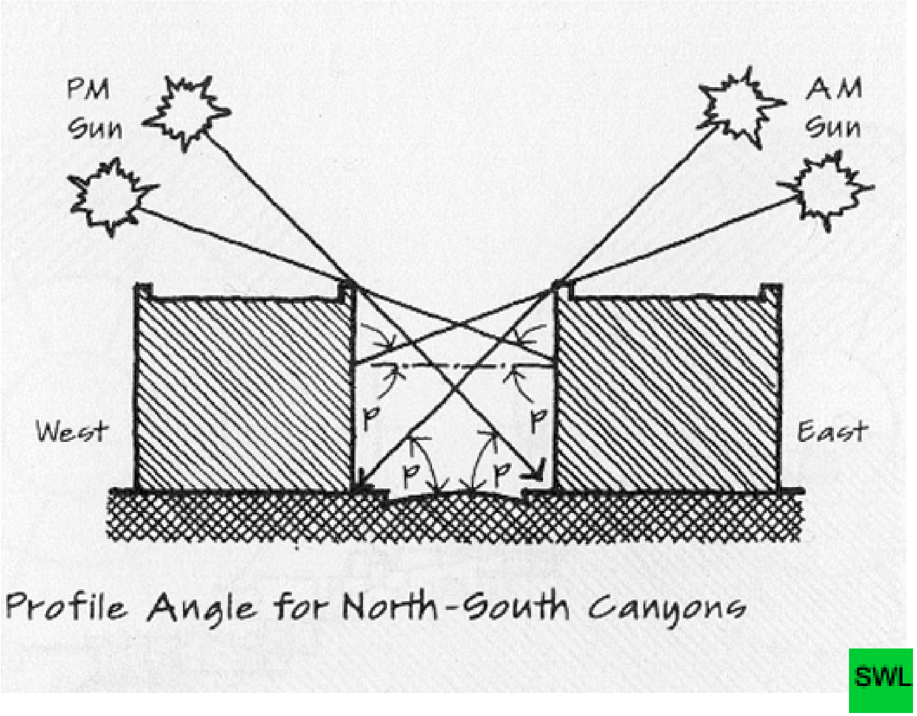
SWL

Solar Access

East-West streets are the easiest to design for solar orientation.

Solar Access

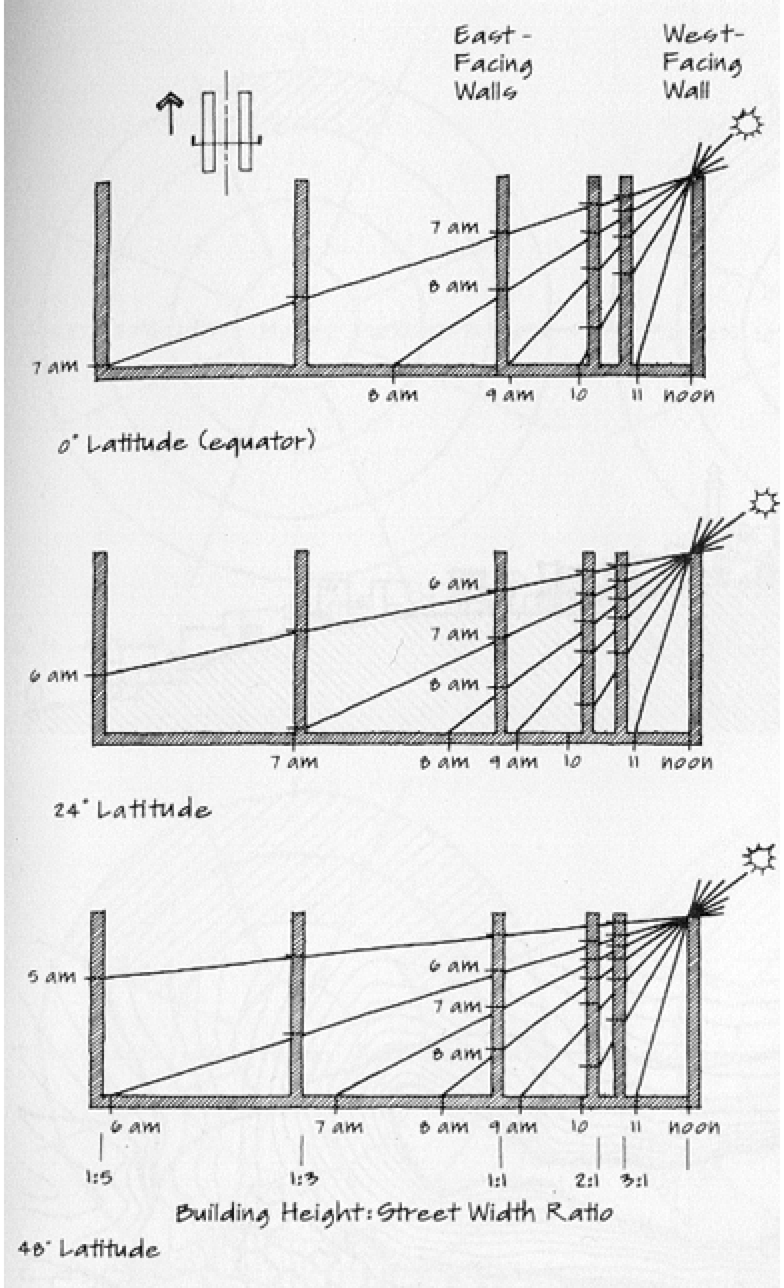




This orientation can be good for various climates -- but its success is a function of the spacing between the buildings and the building height. A north-south canyon can be better or worse than an east-west street orientation, if the east west street is too narrow.

Solar Access

When working with street layouts that have a dominant north-south street orientation, during the morning and afternoon hours, particularly in the winter months, the street level and lower levels of opposing buildings are often in the shade. This is only alleviated by making very wide streets.

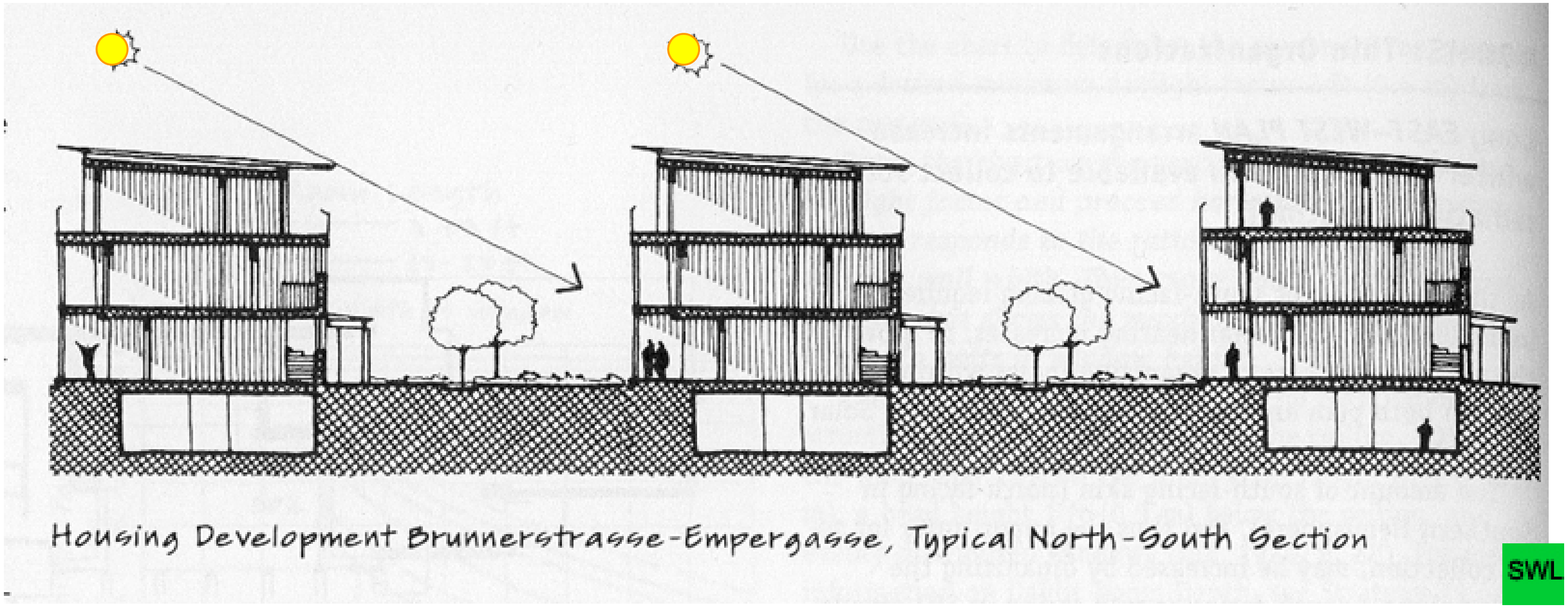


Impact of Cross-Section on Shading Patterns,
North-South Canyons on Jun 21

Solar Access

North-south canyon effect at Bain Avenue Coop, Toronto

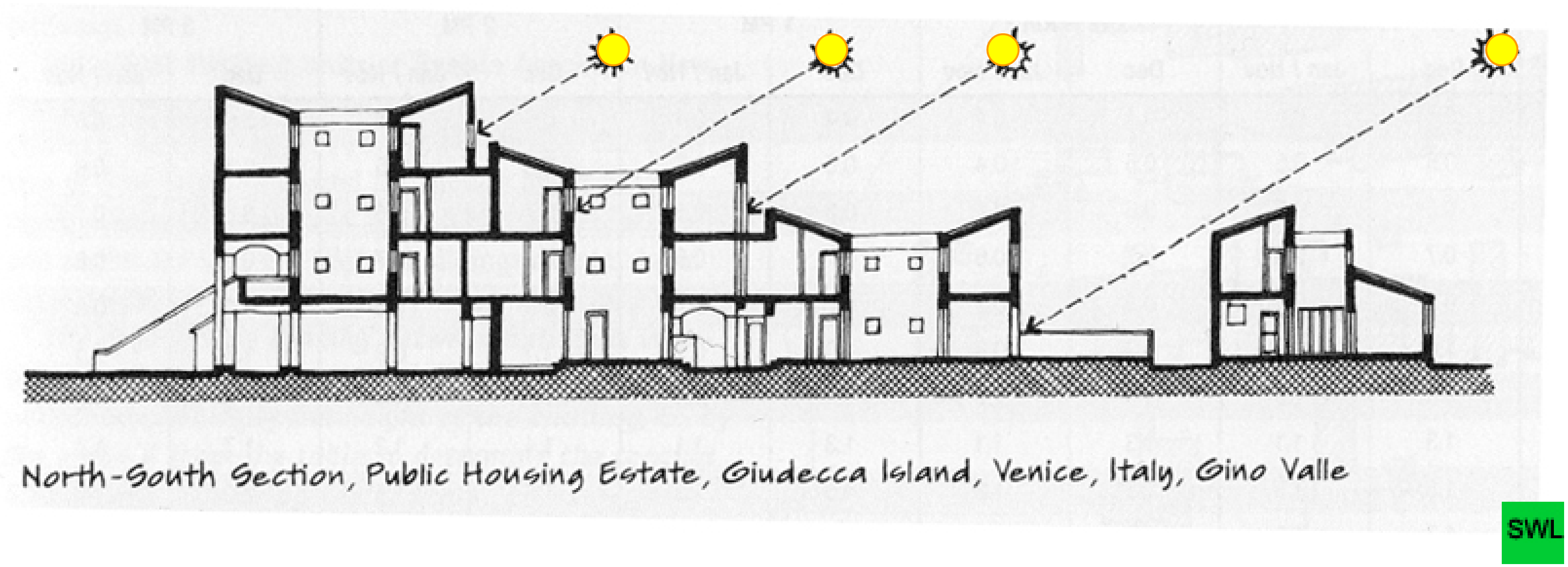
Solar Access



Housing Development Brunnerstrasse-Empergasse, Typical North-South Section

Better solar access is possible with east-west street sections as the south face of the building will get sun for most of the day. Street spacing is adjusted so that the buildings do not block each other's south light when the angles are lowest in the winter (for good design).

Solar Access

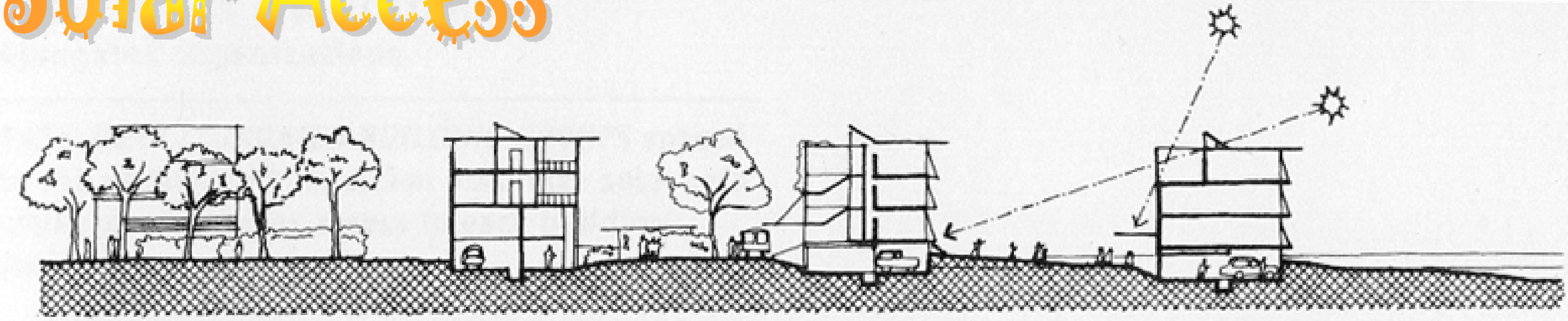


North-South Section, Public Housing Estate, Giudecca Island, Venice, Italy, Gino Valle

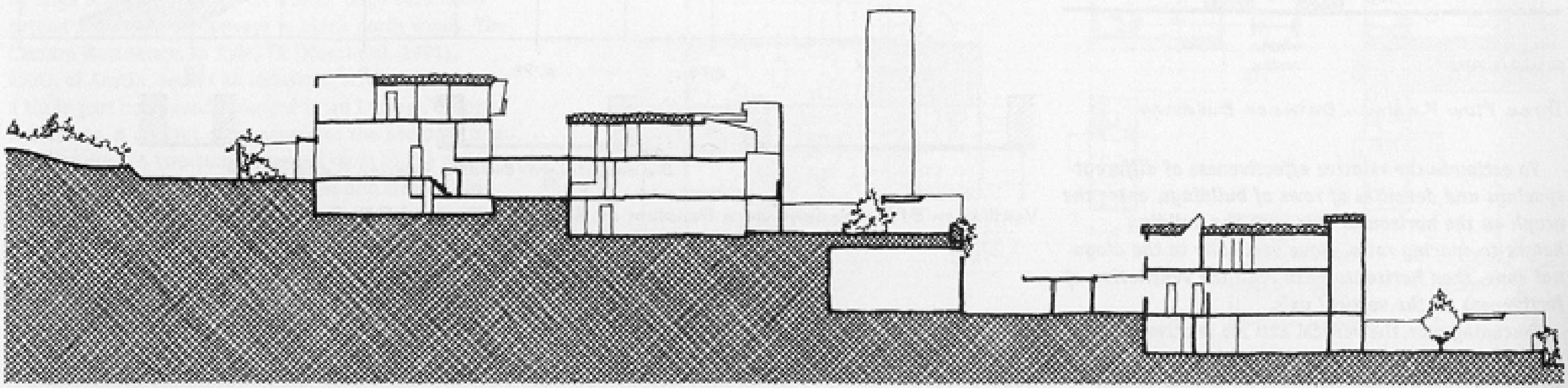
For more complicated sections, the building height and section is adjusted to allow south light to penetrate into various exposures of the building -- in this case through courtyards and clerestory windows.

Solar Access

Solar Access



Solar City Pilching, Linz, Austria, Norman Foster & Partners, Section Through South Sector Housing



Seidlung Halen, Bern, Switzerland, Atelier 5

SWL

During SCHEMATIC DESIGN the solar angles were used to set the distances between the buildings to favor solar penetration.

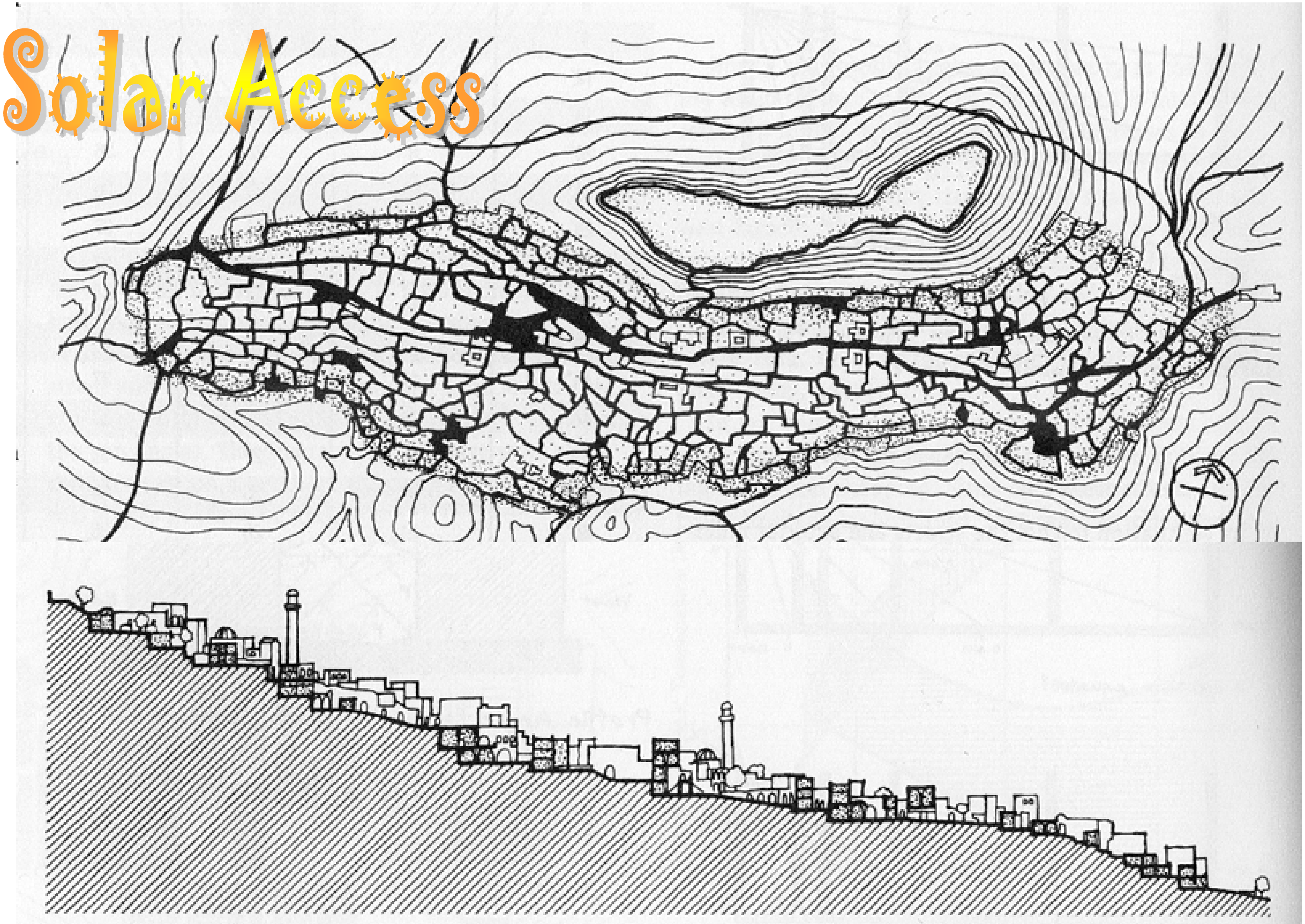
East elevation

West elevation

Different microclimates on the front vs. the back of the house due to materials and orientation (sun).

FYI, Terri's childhood home in Kitchener….

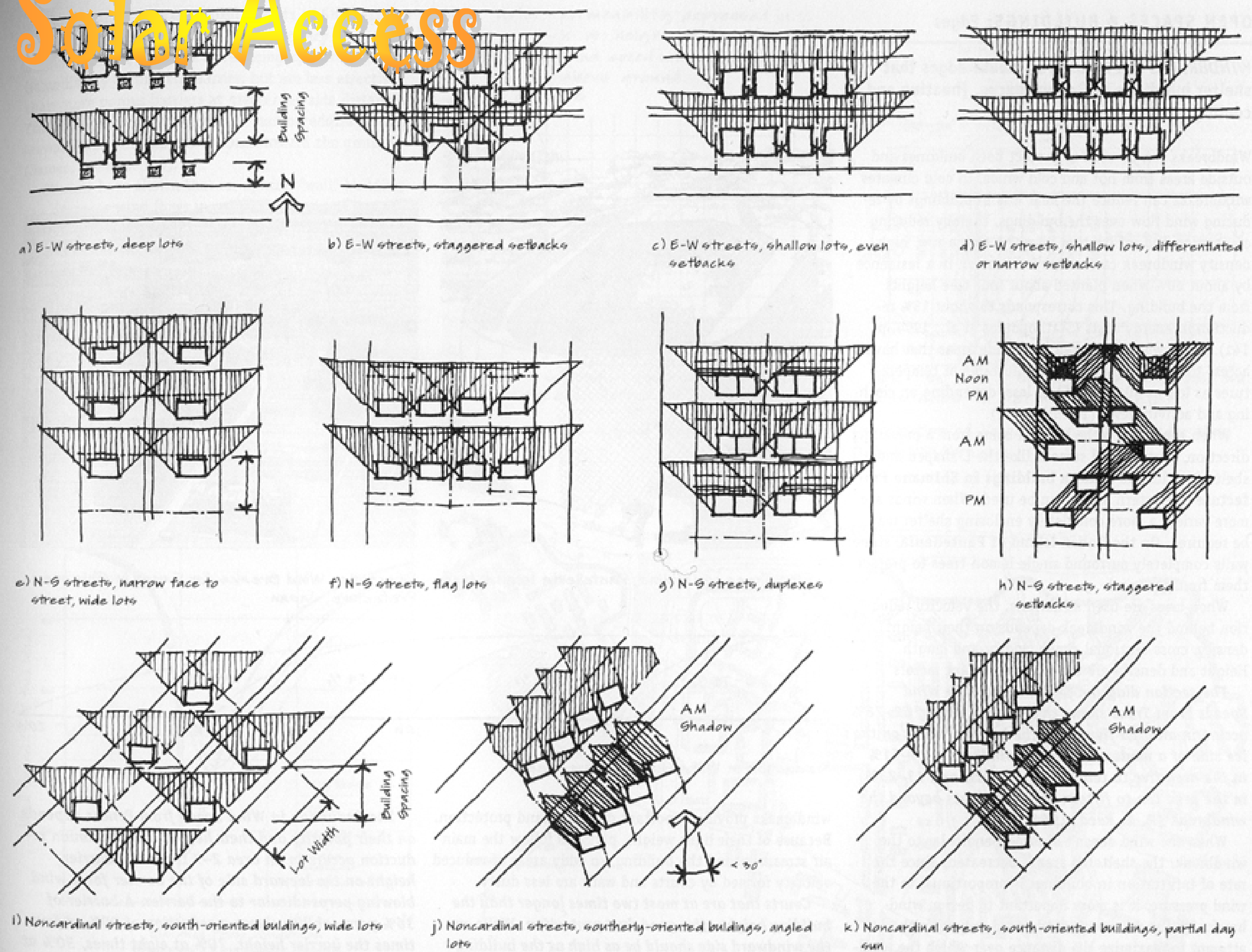
Solar Access



Cross-Section, City of Mardin, Turkey

SWL

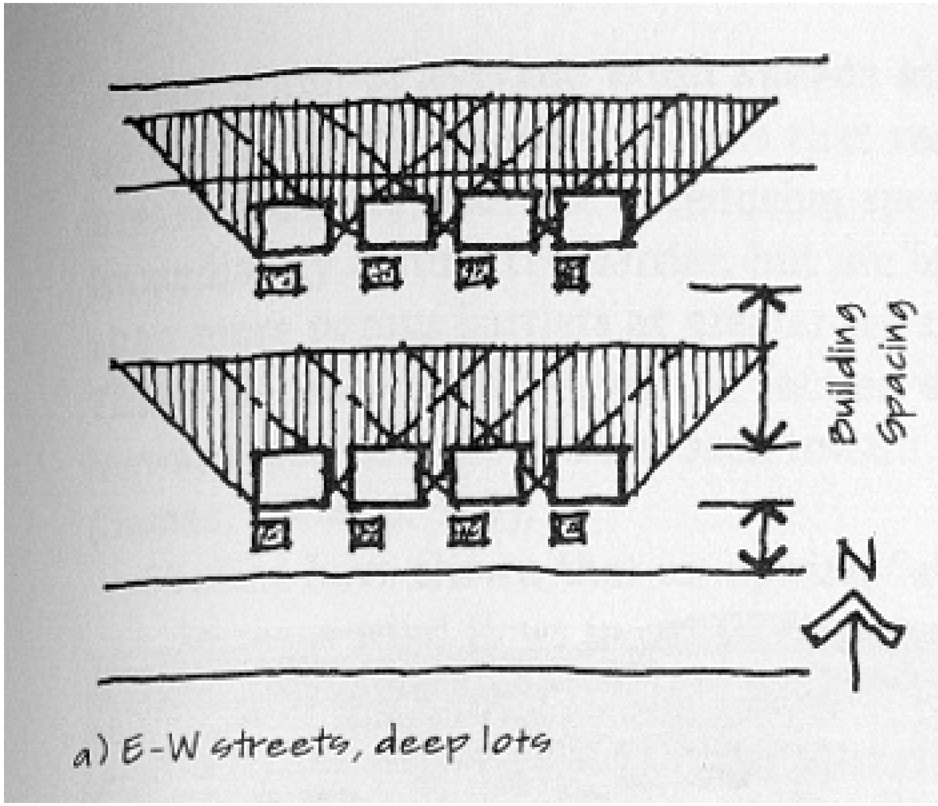
Solar Access

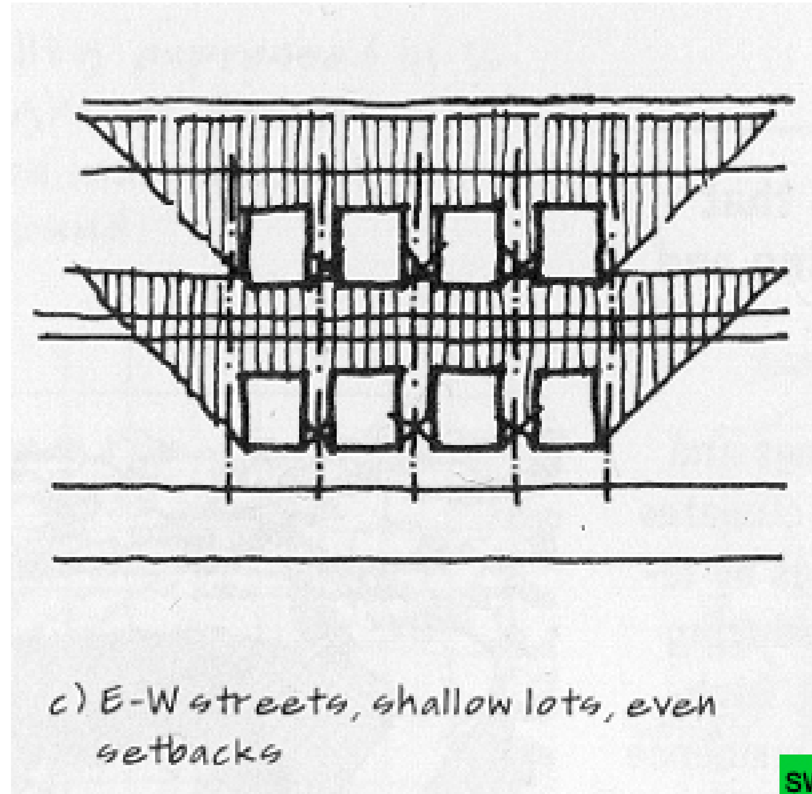


Patterns of Open Space and Buildings for Solar Access

SWL

Solar Access





SWL

Water and Climate

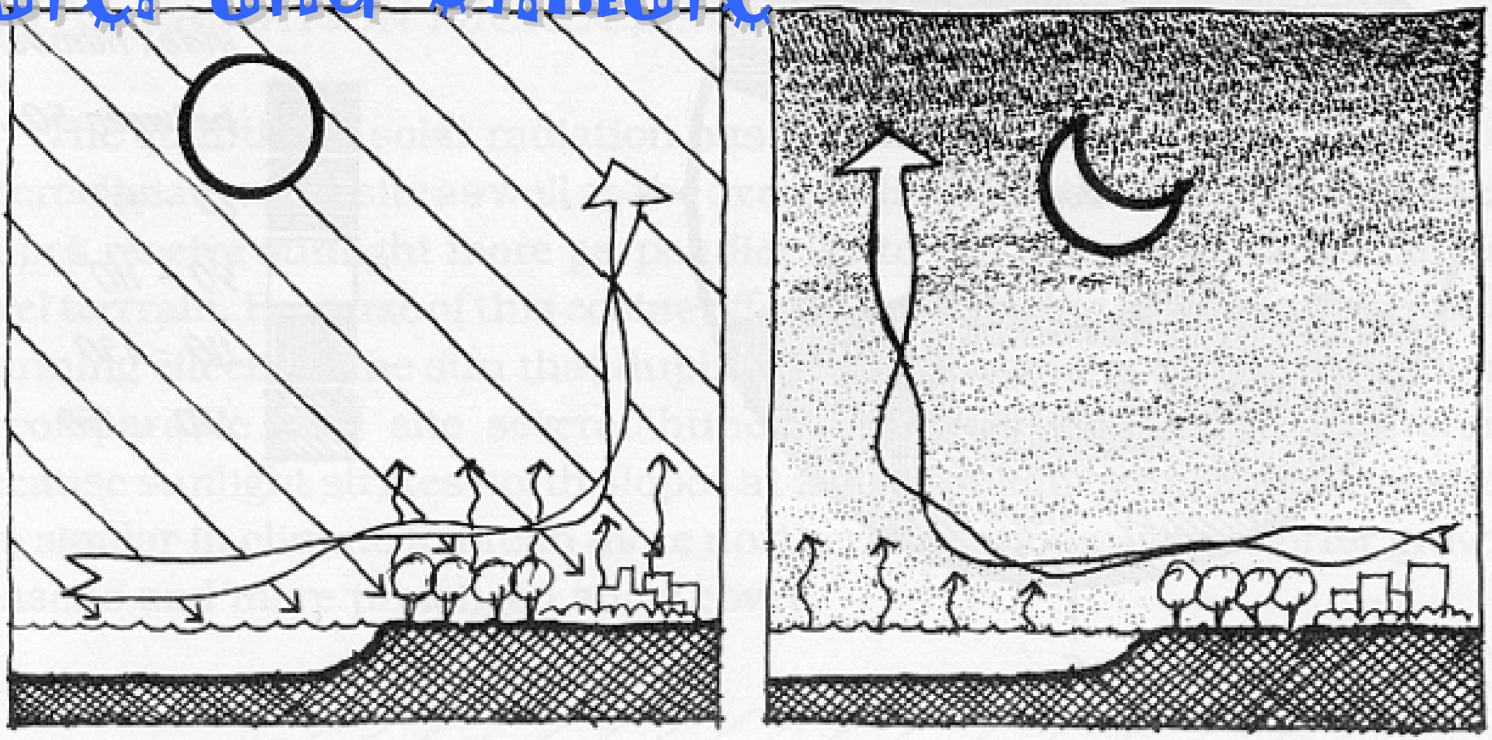
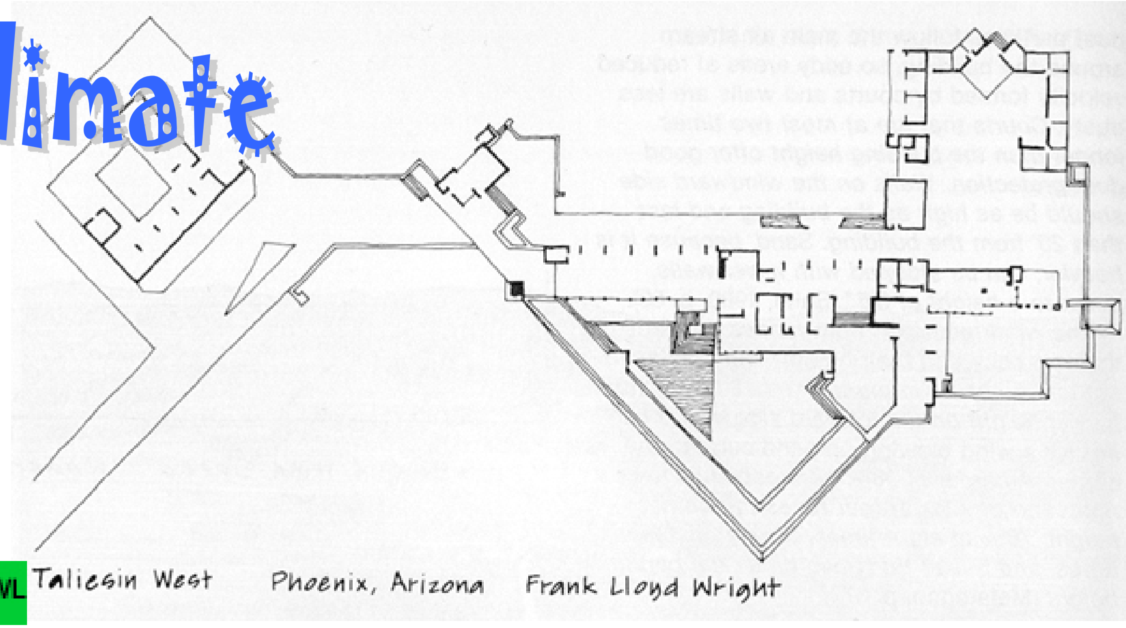


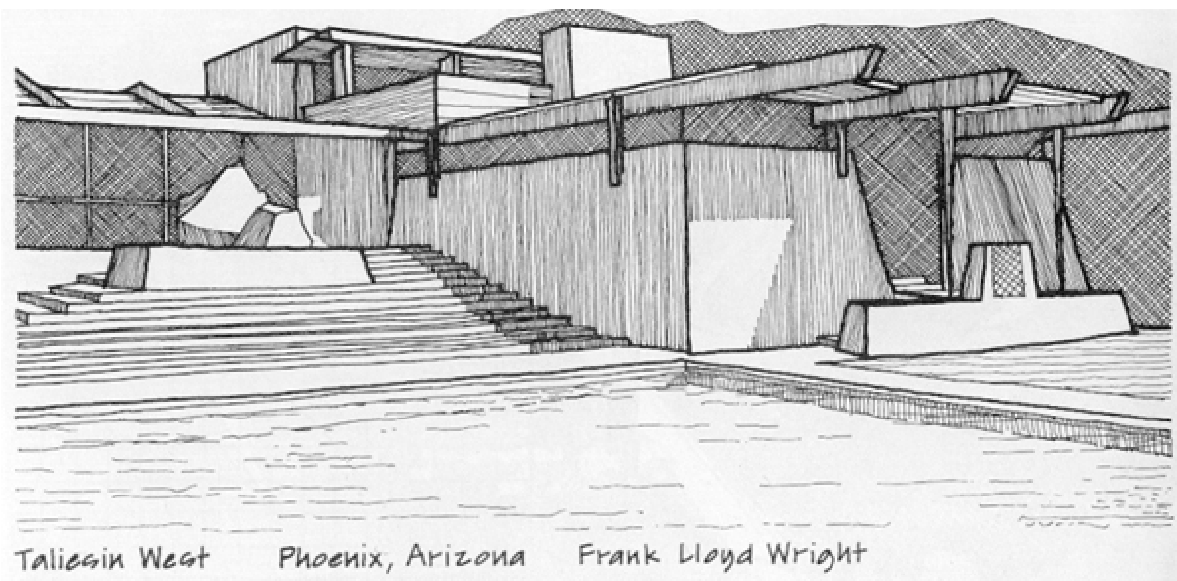
Figure 4.12: Diurnal air movements near a large body of water. *(Redrawn from Robinette, 1977, by permission.)*

Water and Climate

Water beside buildings can be used to cool the local climate. Wind passing over the water can pick up humidity in dry climates and carry it into the building.

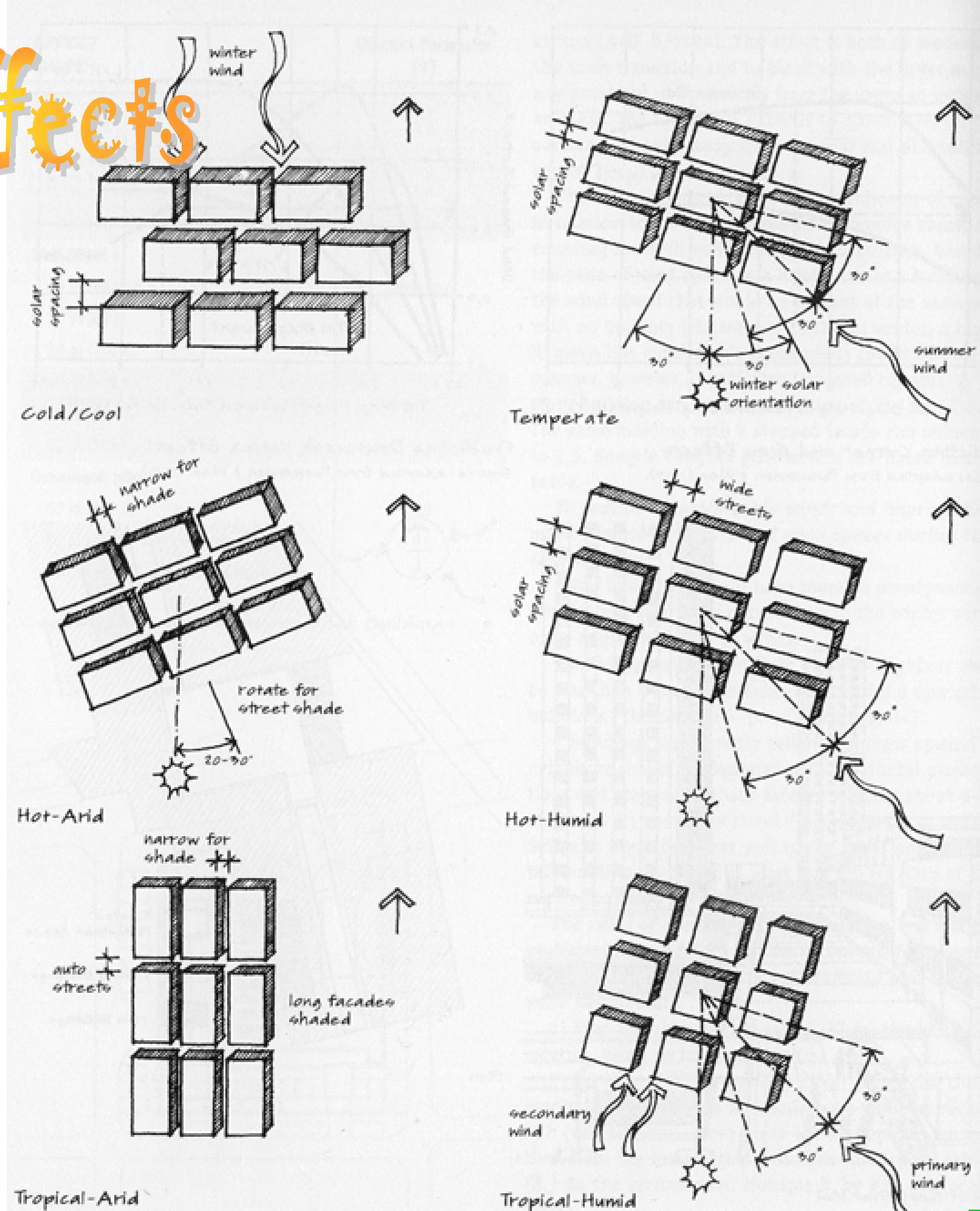
SWL





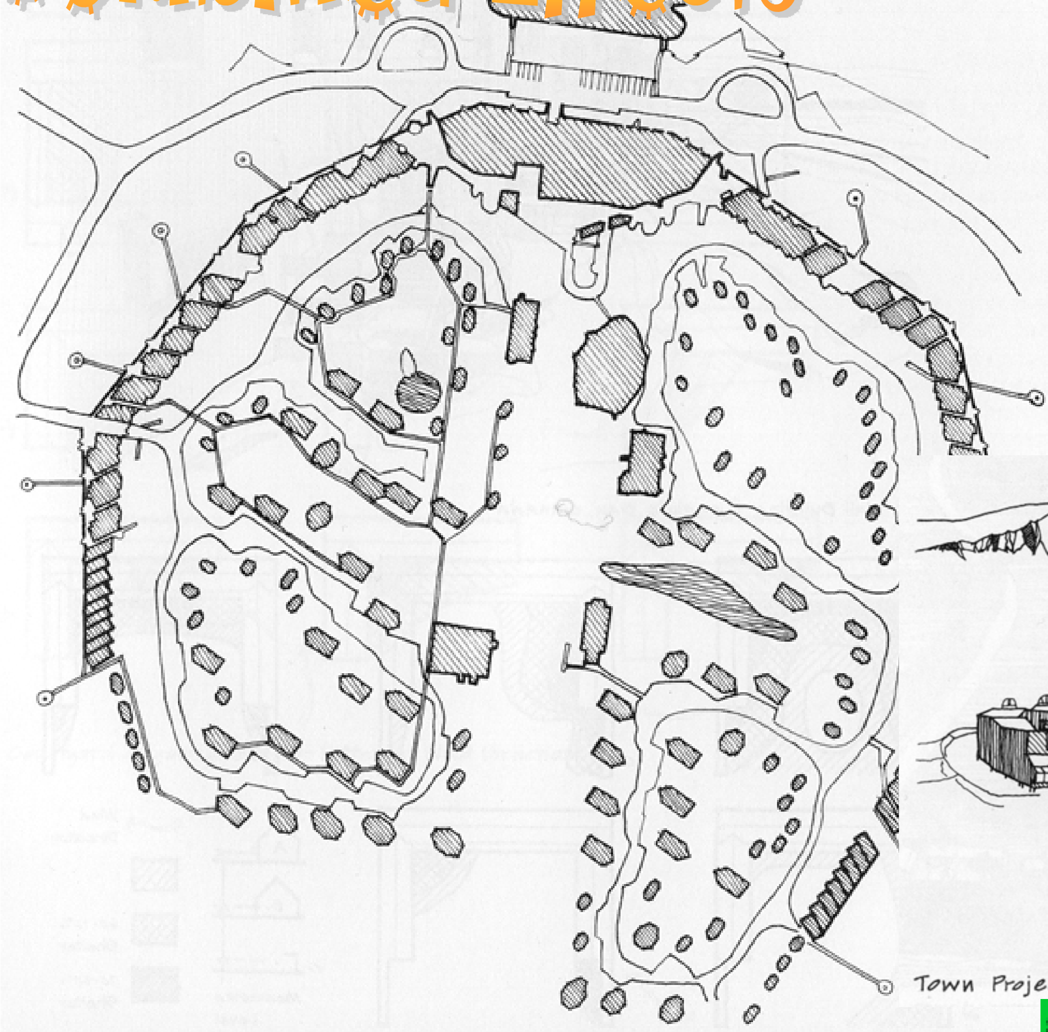
Combined Effects

As with anything else, the architect must consider the combined effects of climate type, wind and sun when laying out building or city plans in order to optimize the situation.



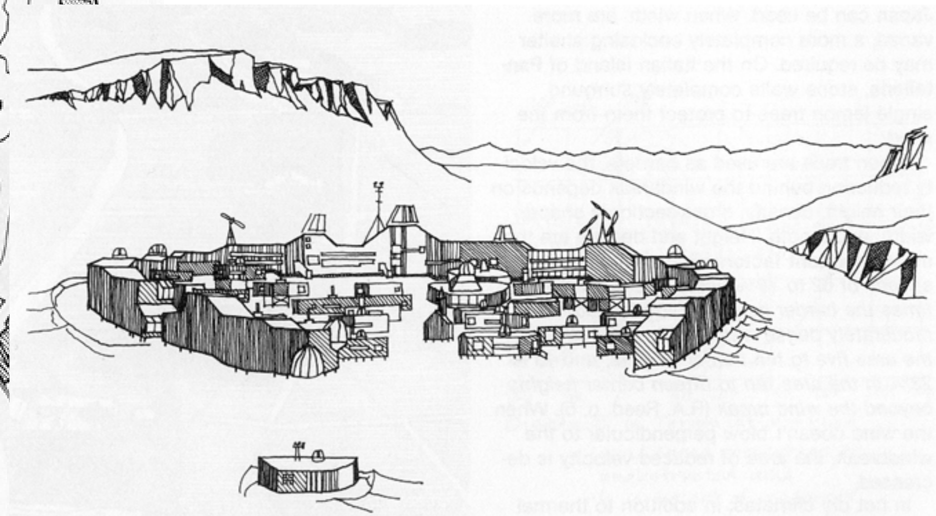
Recommended Urban Patterns in Different Climates

Combined Effects



Township Plan, Resolute Bay, Northwest Territories, Canada, Ralph Erskine

This very cold climate town in the arctic uses sheltering from the wind and solar orientation to create a milder microclimate around the buildings.



Town Project Resolute Bay R. Erskine

SWL

Temperature Guidelines:

To make a site WARMER:

1. Use maximum solar exposures
2. Provide for paved and masonry surfaces on south side of site.
3. Provide vegetational canopies to reduce night cooling.
4. Encourage “sun pockets” on site.
5. Make windbreaks with vegetation or fence like enclosures.
6. Remove shading devices during the day (or winter).
7. Use heat-retaining materials such as concrete or masonry.
8. Locate outdoor terraces for afternoon in the south or southwest.

Temperature Guidelines:

To make a site COOLER:

1. Make extensive use of shade trees as an overhead canopy.

2. Use vines, on trellis, or canopies on south and west facing walls.

3. Use trellises, overhangs -- this also limits heat loss at night.

4. Use ground covers or turf on earth rather than paving.

5. Prune lower branches of trees and reduce close shrubs to encourage air circulation.

6. Provide for evaporative cooling from water elements.

7. Use areas on north and east of building for outdoor activities.

8. Remove windbreaks which would limit airflow during warmer months.

Humidity Guidelines:

To make a site MORE HUMID:

1. Allow standing water to stay on site and limit drainage.

2. Encourage overhead planting which slows evaporation and provides moisture from the plants.

3. Add water elements such as fountains. Also helps from sound of water.

4. Use turf or ground cover instead of paving.

5. Use low windbreaks (below 1.2m) to preserve moisture transpired by turf or ground cover.

6. Use natural wood chip or peat mulch under all plantings.

Humidity Guidelines:

In order to make a site DRIER:

1. Maximize solar radiation exposure on site and reduce shading devices.

2. Maximize airflow and ventilation across the site.

3. Provide an efficient water drainage system for groundwater and storm drainage.

4. Pave all horizontal ground surfaces.

5. Reduce planting, especially ground covers and turf.

6. Eliminate all water bodies, pools and fountains.

Wind Guidelines:

To make a site LESS WINDY:

1. Use extensive windbreaks (plants, landforms, structures).

2. Use outdoor living areas that are semi-enclosed by building or landscape.

3. Do not prune or thin lower branches on tall trees.

4. Locate outdoor activities in areas protected by natural windbreaks.

5. Excavate and place activities partly below ground level in order to use the earth to block winds and require lower windbreaks.

Wind Guidelines:

In order to INCREASE windflow and cooling:

1. Remove all obstructions to prevailing and predictable wind sources.

2. Use plants and landforms to funnel and accelerate breezes.

3. Prune all lower branches of taller trees.

4. Curtail and limit low plant growth between 1 and 10 feet high which would obstruct wind flow.

5. Locate outdoor activities in areas with maximum exposure to prevailing breezes.

6. Build decks or platforms in areas exposed to breezes.

7. Locate evening activities in cool air puddles or in sloped valleys to take advantage of airflow.

Microclimate…

So, by paying attention to the reality of the climate in which our building is situated

-- COLD, HOT ARID, HOT HUMID, TEMPERATE

-- working with SUN, WIND, VEGETATION, TOPOGRAPHY, ORIENTATION, BUILDING SPACING

--we can create a more desirable mini-moderated-climate around our building(s), that can, in turn, make it easier to create comfortable environments in and around our buildings.

…house in a parking lot. Halifax...


The world can't wait:
Fight climate change!

Resources for the Lecture:

"Design with Climate", Victor Olgyay, 1963.

"Environmental Control Systems", Fuller Moore, 1993.

"Sun Wind and Light", G.Z. Brown, 2001.

"Heating Cooling Lighting", Norbert Lechner.

"Climatic Building Design", Don Watson.

"Building Science for a Cold Climate", Hutcheon and Handegord.