MODELS TO CALCULATE THE SURFACE TEMPERATURE

- Radiation models: rsun, SRAD, SolarFlux, Solar Analyst, ASHARE
- Rainfall-runoff: TR-55, MIKE-SHE, CASC2D, HEC-HMC, SWMM, F2D

Land surface Temperature (LST):

- Air temperature: correlates with soil temperature, in clear days is soil temperature bigger than in cloudy days
- Soil temperature on bare ground: daily minimum and maximum air temperature, daily precipitation
- Soil temperature with vegetation: percentage of plant occupation + foliar characteristic (listové)

SRAD Model

- Model for prediction of short and long wave solar energy and fluxes (proudění na zemském povrchu)
- The short and long waves radiation fluxes are then used to estimate the surface energy budget at each grid for a user specific period from 1 year to 1 day
- Calculates solar potencial radiation as function of: latitude, slope, aspect, topographic shading and time of year → monthly cloud cover + direct sunlight
- LST: average monthly surface temperature; min + max + average temperature gradients, elevation of reference climate station
- Consideres aspect, slope, shading on radiation and surface temperature
- Applies method on flat and on slope surface
- Outgoing (long wave) – surface temperature / incoming (short wave) – air temperature + visible sky fraction at each pixel → estimation of surface energy balance (1 day to 1 year)
    - Short wave: solar radiation in the atmosphere, direct and diffuse on flat surfaces under clean sky; direct and diffuse and reflected in sloped surface + effects under real sky conditions and cloudy
    - Temperature: S = ratio of global daily shortwave irradiance on flat and slope surfaces
- Extrapolation from a climate station to another parts of territory – corrected by vegetation (LAI) and elevation
- Net solar radiation (**flux**) – balance between incoming and outcoming energy at the top of the atmosphere. It is total energy that is available to influence the climate (teacher says ii is the amount of energy available on the surface of the terrain and involved in the proces of heating evaporation and photosyntesis)
- **Input data**: calculation period, DEM, parameter file specific to each position, vegetation file

Surface temperature estimation from satellite data: MODIS, ASTER, Terra / Copernicus has LST (generated from GEOS, Meteosat Second Generation and MTSAT)

- Aster: 90m / MODIS: 1 km but daily

USAGE: agriculture, resource management, meteorology, civil engineering, ecological research

SOLAR RADIATION MODEL (ARCGIS)

- Perform: area, points, chart (visible sky = visual basin map, position of the sun in the sky for a period of time = solar map, sky sectors that influence the amount of solar radiation incoming = skymap)
- Topography is major factor, slope, aspect, orientation, shadows ← changes according to the time (day, year)
- Map and analyze the effects of the sun over a geographic area in specific time
- Count with direct and diffuse radiation
- Steps:
    - Calculation of upward looking hemispherical viewshed based on topography (sensor in open field has bigger insolation than sensor in a deep valley) → viewshed is raster (+ sun position and sun direction – sunmap and skymap)
    - Overaly of the viewshed on a direct sunmap to estimate direct radiation
    - Overaly of the viewshed on a diffuse skymap
    - Repeat the proces for each location to produce an isolation map

- Sunmap: discrete sunmap sectors defined by the sun position at particular intervals during the day (hours) and time of year (days or months). The sun track is calculated based on latitude and the time configuration
- Skymap: diffuse radiation is calculated for each sector based on zenith and azimuth.
- → overlay of viewshed with sunmap and skymap.
- **Calculating of solar radiation**:
    - global radiation: sum of direct and diffuse
    - direct: solar constant, transmisivity of atmosphere …
    - diffuse: global normal radiation, proportion of global normal radiation flux that is diffused (0,2 for clear sky, 0,7 for cloudy), time interval, proportion of visible sky
- Viewshed map: is the raster representation of the sky that is visible…, depends on the number of visuals used

ATM MODEL

- satellite-imagery analysis

SOLARFLUX

- model in SIG

SOLEI-32

- land cover + ground albedo + meteo data

RADIATION MODELS IN URBAN ENVIRONMENT

- reflected radiation is measured only on non flat areas
- Fortran: sw, quick calculations, only text results + Energy plus = calculation based
- 2D: parasol, arcgis solar analyst, r.sun,
- 3D: sketchup, v.sun grass gis, ecotect, green building studio

r.sun

- Estimates the photovoltaic potential on the roofs
- DTM, output – shading algorithms and solar radiation calculations
- Direct, diffure and reflected for clear and cloud sky
- Input: topo and meteo

v.sun

- Can count the solar radiation for a specific instant or sum of solar radiation during the specific time period of time with a spefific time step.
- Vector-voxel approach
    - Segmentation of polygons into smaller elements. Voxel can be easily applied for shading algorithms and segmetation of polygonal surfaces
    - 1.: division of urban zone volume using a voxel data structure. Segmetation rule of voxel resolution for spatial polygons what define object → each new polygon fits into one voxel.
    - 2.: required solar geometry parameters are calculated for each segmetation element including a normal vector and vectors defining the direction of solar rays
    - Shading algorithm (uses bit mask of voxel or projection technique). The speed and sampling precision is based on voxel resolution.
    - All calculations of the solar geometry and shadow analysis → values of solar radiation (direct, diffused, reflected)
- Effect of shading on neighbourhoods buildings
- **SOLWEIG**: 3D variation fluxes and temperature in urban complex settings, 6 directions
- Methodology: European Atlas of Solar Radiation (ESRA), different treatment for diffuse component, turbidity index of Linke
- Two modes: instant calculations (W/m2) and daily amounts (Wh/m-2)
- = it is vector-based gis program with solar input parameters defined as spatial variables in a raster-voxel forma tor as constant
- All radiation components with clear and real sky as irradiation and irradiance
- For solar of civil time

MODELS FOR WATER BALANCE

Wet model: precipitation, evaporation, deep drainage (hluboké odvodnění) or percolation (pronikání), runoff (odtok)
Dynwet-G: topographic moisture index (topografický index vlhkosti) based on dynamic or static subsurface flow.
Thornthwaite model: from rainfall and runoff data. Result is empirical relationship between potencial evapotranspiration (PET) and air temperature
Turc model: DEM + available soil water capacity (AWC) + monthly temperature + precipitation + solar radiation. Calculates PET. Moisture inputs are precipitation and moisture reserves in soil and the outputs are real evapotranspiration and surface runoff.

SOLAR RADIATION

- Control the surface energy and water balance and thus affects the atmospheric, biophysical and hydrologic processes (provides sources of renewable energy)
- Surface net radiation: spatially and temporaly variable what depends on: orientation of the Earth relative to the sun, topography (slope, aspect, shadowing), clouds and other atmospheric properties, land cover

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It is described by the Linke turbidity index, which indicates the optical density of the mist and humidity of the atmosphere with respect to a clean and dry atmosphere.

We distinguish two terms for solar radiation (shortwave):

- Irradiance: Solar energy that falls on a unit area per unit time.
- Irradiation: Amount of solar energy falling over an established time interval.

Water File

It allows us to know the annual water balance in dif. Studies. With the annual results we can obtain derived indexes for the climatic allocation of Thornthwaite (aridity, humidity or water).

OCK - MRK

There is no optimal method to define the spatial model of mean precipitation corresponding to an area of complex climatology. In fact, it is observed that for the summer the most appropriate method to characterize the precipitation model is the MRK, whereas for the winter it is the OCK. It is not so easy to indicate which method is best for spring and summer, because depending on which parameter is used to measure them, the results are better in one case or another.

El mapa solar es (sun map):

- La represanticion raster de todas las posibles posiciones del sol a lo largo del ano desde una posicion
- Dependiente del numero de visuales que se empleen al definir al mapa celeste
- El modelo vectorial – NO
- El mapa que se emplea para determinar la radiacion solar directa incidente en cada pixel.

El índice de turbidez de Linke:

- Es más elevado en invierno que en verano / It is higher in winter than in summer
- Aumenta con la temperatura del aire y la contaminacion / Increases with air temperature and pollution
- Es especialmente elevado con aire muy seco
- Su valore es contante en practicamente todos los puntos de la Tierra a nivel del mar
- Ninguna

This turbidity factor has a dynamic nature that generalizes this attenuation of the radiation.
It typically ranges between 3 (clear skies) to 7 (heavily polluted skies). It is a very convenient approximation to model the atmospheric **absorption** and **scattering** of the **solar radiation under clear skies**.
It describes the optical thickness of the atmosphere due to both the absorption by the water vapor and the absorption and scattering by the aerosol particles relative to a dry and clean atmosphere. It summarizes the turbidity of the atmosphere, and hence the attenuation of the direct beam solar radiation. The larger TL, the larger the attenuation of the radiation by the clear sky atmosphere.

El modelo SOLEI-32 es un modelo para obtener:

- *Mapas de precipitationes*
- *Solamente modelos de temperatura*
- *Estimacion de la energia potencial incidente en una superficie*
- *La componenta reflejada de la radiacion solar solamente*
- Ninguna

SOLEI-32 is a model for estimating solar radiation. Requires optional soil use, soil albedo and meteorological data. This last data consists of a file with values of relative insolation, temperature, wind, relative humidity of the air and vapor pressure for all control points defined in the study area. If only terrestrial and / or terrestrial albedo data are provided, Solei-32 will provide potential incoming solar radiation.
The model first calculates the topographic attributes and the duration of sunlight at each step of the time for each pixel in the DEM. Then, the estimation of the potential energy entering the inclined surface is made as the sum of direct, diffuse and reflected components. For those pixels where the direct duration of the sun is equal to zero, it is assumed that the potential energy input is equal to the diffuse radiation.

Las afirmaciones correctas referidas a CityGML:

- *Un lenguaje creado para crear modelos hydrograficos*
- Permite crear modelos 3D de areas urbanas
- *Permite estimar la radiacion reflejada por las superficies en onda larga*
- Emplea hasta 5 niveles de detalle al crear los modelos 3D
- *Calcula la temperatura en los tejados de las areas urbanas*

En la expresion que permite calcular la temperatura en el modelo SRAD:

- Interviene el parametro LAI como indicador de la cantidad de vegetacion
- Interviene una constante para todo tipo de cubiertas vegetales
- *No interviene nada más que el parametro temperatura de aire*
- No se tiene en cuenta la elevacion de cada posicion y la temperatura de la estacion de referencia se extrapola a todas las posiciones
- Se realiza una correction de la temperatura de referencia por variacion de altura para cada pixel

SRAD Provides radiation estimation across short and long wave components, net irradiation, as well as surface and air temperatures. The model calculates potential solar radiation as a function of latitude, slope, orientation, topographic shading and time of year, and then modifies this estimate using information on average monthly cloudiness and sunshine hours. Short-wave and long-wave radiation flows are used to estimate the surface energy at each point on the grid for a period specified by the user, ranging from 1 day to 1 year.

Los modelos de balanco hydrico, como Thronwaite y Turc, se diferencian entre ellos de forma signular en:

- La unidad espacial de trabajo
- La interpetacion temporal de los resultados
- La forma de determinar la variacion de la reservar
- La estimacion de la radiacion solar
- La determinacion de la evapotracporacion potencial

The radiation attenuation by solid and liquid particles:

- Is described by the Linke index

In the Turc Model to apply a water balance:

- It is possible to consider the study are both as a dry or humid area
- *The solar radiation is never used*
- *The evapotranspiration is calculated as function of the annual temperature*
- *It appears in the balance only the available water capacity*
- *The topographic modelling of the study area is very important since the water behaviour of a pixel depends on the slope, aspect, curvature*

Turc model: DEM + available soil water capacity (AWC) + monthly temperature + precipitation + solar radiation. Calculates PET. Moisture inputs are precipitation and moisture reserves in soil and the outputs are real evapotranspiration and surface runoff

1. Explica que es la cuenca visual, como se calcula a para que sirve // viewshed
    - The viewshed is a raster representation of the entire sky that is visible or obstructed when viewed from a particular location. A viewshed is calculated by searching in a specified number of directions around a location of interest and determining the maximum angle of sky obstruction, or horizon angle. For all other unsearched directions, horizon angles are interpolated. Horizon angles are then converted into a hemispherical coordinate system, thus representing a three-dimensional hemisphere of directions as a two-dimensional raster image. Each raster cell of the viewshed is assigned a value that corresponds to whether the sky direction is visible or obstructed. Output cell locations (row and column) correspond to zenith angle θ (angle relative to straight upward) and azimuth angle α (angle relative to north) on the hemisphere of directions. The figure below depicts the calculation of a viewshed for one cell of a DEM. Horizon angles are calculated along a specified number of directions and used to create a hemispherical representation of the sky. The resultant viewshed characterizes whether sky directions are visible (shown in white) or obstructed (shown in gray). The viewshed is shown overlaid on a hemispherical photograph to demonstrate the theory. Viewsheds are used in conjunction with sun position and sky direction information (represented by a sun map and sky map, respectively) to calculate direct, diffuse, and total (direct + diffuse) radiation for each location and to produce an accurate insolation map
2. Explain what is sky map, how is it calculated and what is it used for
    - Diffuse radiation originates from all sky directions as a result of scattering by atmospheric components (clouds, particles, and so forth). To calculate diffuse radiation for a particular location, a sky map is created to represent a hemispherical view of the entire sky divided into a series of sky sectors defined by zenith and azimuth angles. Each sector is assigned a unique identifier value, along with the centroid zenith and azimuth angles. Diffuse radiation is calculated for each sky sector based on direction (zenith and azimuth). The figure below is a sky map with sky sectors defined by 8 zenith divisions and 16 azimuth divisions. Each color represents a unique sky sector, or portion of the sky, from which diffuse radiation originates.
3. In the Valencian precipitatin study, how was computed the multiple regression with residual krigging model?
    - OK was used and spherical and exponential kriging. The regression residuals were krigged in order to correct for any local under or overstimation. Steps: 1. compute residuals from MR -> apply OK method on these residuals and obtain estimation of them in each location
4. Explain, how the authors of the article about landslides have selected the samples for statistical analysis
5. Explain when you think it is more convenient to model the precipitation in an area using cokrieago and with the multiple regression method with kriging of the results
6. Explain how the group of variables SUPDIF, SUPDISTF, SUPDIFDIS, ALTDIF, ALTDISTF,, ALTDIFDIS have been calculated in the study on precipitation in velanciano territory and that work to measure
    - A new group of variables (SUPDIF, SUPDISTF, SUPDIFDIS, ALTDIF, LTDISTF and ALTDIFDIS) was added to solve the problem of precipitation shadows. Steps: 1. From the centroid or each hillside the highest point inside an area orriented according to synoptic flow or 850hPa by Python programming. Within the coordinates and elevation of the highest point and the centroid, the distance between them (variables SUPDISTF and ALTDISTF) as well as height difference (SUPDIF and ALTDIF variables) can be calculated. The relationship between them (variables SUPDIFDIS and ALTDIFDIS) measures the effect of the orographic barrier.

I. Explain how the deficit and the water excess of a water basin can be quantified and mapped
II. Explain that it is the SRAD model and what it is used for, indicating the input data it needs, as well as the results it generates
    - SRAD Provides radiation estimation across short and long wave components, net irradiation, as well as surface and air temperatures. The model calculates potential solar radiation as a function of latitude, slope, orientation, topographic shading and time of year, and then modifies this estimate using information on average monthly cloudiness and sunshine hours. Short-wave and long-wave radiation flows are used to estimate the surface energy at each point on the grid for a period specified by the user, ranging from 1 day to 1 year.
III. What is the difference between the values of radiation in real and clear skies? Can calculations of radiation over clear skies be useful?
    - A maximum global radiation is obtained when the sky is absolutely clean and dry. Less radiation is received when aerosols are also present. Clouds are the strongest attenuators. If all the factors of the atmospheric attenuation are taken into account, one works in conditions of real sky (cloudy). If the attenuation of the clouds is omitted, a clear sky model is used.
    - The reflected radiation is only analyzed in non-flat areas. In urban areas, this component can be very important because of the complex morphology and high reflect. Of many urban surfaces. A maximum global radiation is obtained when the sky is absolutely clean and dry. Less radiation is received when aerosols are also present. Clouds are the strongest attenuators. If all the factors of the atmospheric attenuation are taken into account, one works in conditions of real sky (cloudy). If the attenuation of the clouds is omitted, a clear sky model is used.
IV. It explains how the MRK model (regression krigging of residues) has been obtained, the advantages that it presents against the multiple regression model. Indicate what period of the year works more precisely and why
V. Explain, why and how is applied the vector-voxel approach in the urban areas?
VI. One of the two studied method to get potencial evapotranspiration in the Thorntwhite model – explain as much as possible
VII. Explain, what factors should be taken into account in order to calculate the solar beam radiation for the inclined surface
VIII. In the precipitation study on valencia region, hillsides are one of the different types of influence are sused in this study. What variables have been using this influence area?