Exercise – Raster Overlay Analysis (using the Suitability Modeler)

Introduction

As part of the Kyoto Protocol, Denmark is committed to reduce greenhouse gas emissions.
This commitment is based on the scientific consensus that human-induced global warming is occurring and that the emissions of greenhouse gases, incl. CO_2, are driving it.

Afforestation = planting of a forest in an area without recent tree cover.

One way to reduce a country´s greenhouse gas emissions, is to plant more trees - afforestation.
Trees take up airborne CO_2 during photosynthesis and turn it into carbohydrates for growth.
By sequestering CO_2 from the air, trees act as carbon sinks, during their lifetime, and even longer time, if the dead matter is left to decompose and become a part of the soil, rather than being harvested.

IGN = Dept. of Geosciences and Natural Resource Management (or Institut for Geovidenskab og Naturforvaltning, in Danish)

In 2022, this institute was assigned by the Danish Environmental Protection Agency, to develop a methodology, by which it would be possible to find the most optimal sites in Denmark to plant new forests.

National Forest Plan

This is a part of the national 'Skovplan' (Forest Plan), which seeks to increase the forest-covered area in Denmark to a total of 20-25% during the 21st century (Today, approx. 15% is covered).

The output of the work which the IGN completed, is summarized in this report (in Danish).

As the title of this exercise is implying, this exercise is about bringing several layers of raster geodata together.
This is in perfect analogy with a previous exercise, where you also were bringing various layers of geodata together, in order to find the optimal location.

Raster vs. Vector overlay

However, that time the layers were in the *vector* format.
You will find that the principle of raster overlay is similar.
You only need to pay attention to a few other things, which are inherent to the raster data format.

Suitability Modeler

To your help, a specific tool has been put together by the ArcGIS Pro developer team – the Suitability Modeler.
The Suitability Modeler is actually an entire workflow, which is quite intuitive, flexible, and will help you appreciate some of the considerations you need to make during raster overlay.
Moreover, the Suitability Modeler is quite powerful, making it possible to extract the most suitable sites in little time.

Introduction

The Suitability Modeler is quite an extraordinary tool.
Because, the suitable 'sites' are ***not*** just the ***individual*** pixels with the highest accumulated values from the included layers.
The output sites are actually several pixels connected together, to form a consecutive area, with for example the highest average of accumulated pixel values (compared to any other combinations of pixels in the studied area) (Fig. 1).

Sites vs. individual pixels

This is the new and powerful thing – the fast extraction of *sites*, rather than just the individual pixels with the highest numbers.

(Without this functionality, the Suitability Modeler would not have offered much new innovation, because raster overlay operations have been the mainstay of GIS analysis for decades.)

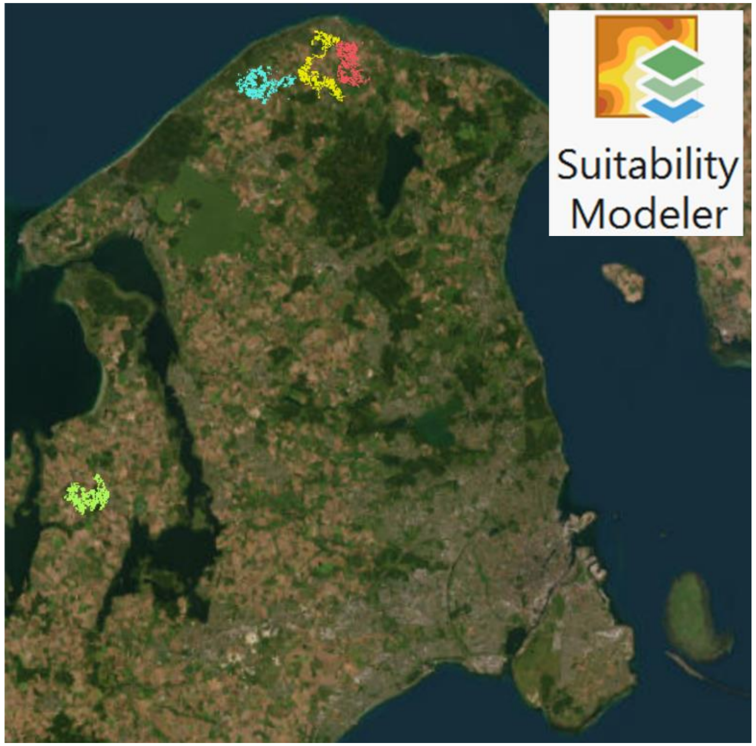


Fig. 1 An example of the output of the Suitability Modeler. Four sites suitable for afforestation are highlighted in red, yellow, green and blue.

Objective

Aim:

In this exercise we will show you some of the true powers of GIS:

- How very large datasets may be processed in short time.

- How we may present results in a very comprehensible way, so that any layman may understand it.
  Indeed, this is an important aspect, as we may explain research to politicians and other decision-makers, who may know little about GIS.

You will:

* Be introduced to the ArcGIS Pro Suitability Modeler.

* Learn more about the raster data format and its geoprocessing.

* Be introduced to one type of GIS analysis, which may serve as inspiration to your Project.
  (Mind you, there are so many GIS tools and methods, so you do not have to re-use any presented in our exercises.)

Exercise

1. Start a new ArcGIS Pro project (Name it and save it to a familiar location, *e.g.* your H/T drive).

2. From the *I:\SCIENCE-IGN-CGD-UVMAT\GIS_course\Exercises\ArcGIS_Pro\Exercise_RasterOverlay_Analysis\Geodata*, copy the folder called *InputGeodatasets* to your new ArcGIS Pro project folder.
(This folder has a geodatabase with the same name, which is containing some geodatasets that you will use.)

3. Use your skills to copy the following geodatasets from the *InputGeodatasets.gdb* to your new project .gdb:

The Surface Water Runoff layer, developed by Thomas Balstrøm, associate professor at the IGN

- *SurfaceWater_100m_Weighted_1_10*
- *Region_Hovedstaden_Mainland_10k_DigDag_SDFI_2017*

4. a) Add the *SurfaceWater_100m_Weighted_1_10* geodataset to the Map View (Fig. 2).
This is a Danish nationwide raster layer, where each pixel is representing 1 ha = 10 000m^2 (100m x 100m).
Moreover, each pixel has been given a value from 1 to 10.

1 hectare (ha) = 100m x 100m

b) Use you skills to symbolize the layer from **red-to-green**, based on the field called Value (Fig. 2).

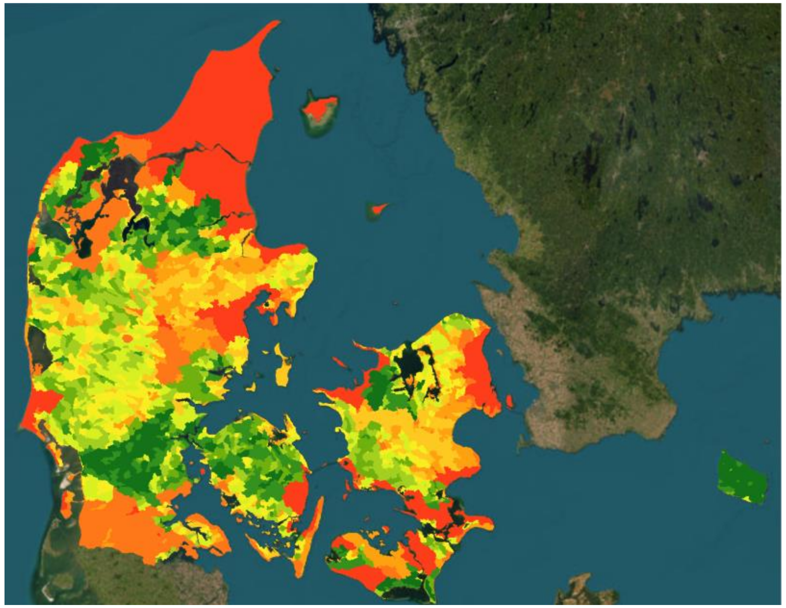


Fig. 2 The national Surface water runoff raster layer Pixel size: 100m.

Nitrogen leakage

Excess nitrogen is leaking from the agricultural land to the surrounding landscape, particularly by surface runoff, and then further via streams and rivers to the lakes and the coast.

The values are representing a combination of the amount of nitrogen leakage in a particular pixel, AND the proportion of that leakage that reaches the final recipient.
So, a low pixel value (red) means that there is relatively little nitrogen leakage at the source, and a little proportion of this reaches the lakes and the coast, and vice-versa.

Now, recall that the ultimate purpose of this exercise, is to find the optimal sites for planting new forests.

Then, clearly, it would be better to plant trees on a pixel with a higher value (green), since we would reduce nitrogen leakage in the landscape (while storing more CO2 at the same time).

Exercise

In this exercise, we are not going to study the whole of Denmark.
We are going to focus on the Capital city Region (Region Hovedstaden), covering Copenhagen and Northern Zealand.
The main reason is to teach you some useful raster processing operations, but also to save some time (although raster overlay operations often require less processing power than vector overlay).

Region Hovedstaden (minus the islands of Bornholm and Hesselø)

5. a) Add the *Region_Hovedstaden_Mainland_10k_DigDag_SDFI_2017* feature class to the Map View (Fig. 3).

If you study this layer in the Map View, you will notice that it consists of several individual polygon features, and each one is representing a distinct area separated from the other polygons (like the island of Amager in the southeast corner of figure 3).

b) Now open the Attribute Table of this layer.

What do you see?
In the Attribute Table, there is only one row…? (Fig. 3, bottom)
Doesn´t that mean that there is only one polygon feature in this feature class?
Answer: Yes and No.
The correct answer is that all those separate polygon features are represented <u>as one feature</u>, called a multipart feature.

Multipart feature vs. Singlepart feature

Making use of multipart features has certain advantages.
For example, you do not need an overextended Attribute Table, with thousands of individual rows, each representing an island in a country like Denmark, which has a lot of them.
Reducing the number of rows in the Attribute Table also has its advantages for performance during geoprocessing.

Multipart To Singlepart tool

That said, there are situations where you would like each feature to be represented by its own row in the Attribute Table.
No worry, you may fix this with the Multipart To Singlepart tool in the Geoprocessing pane. (Please try it out on your own if you like.)

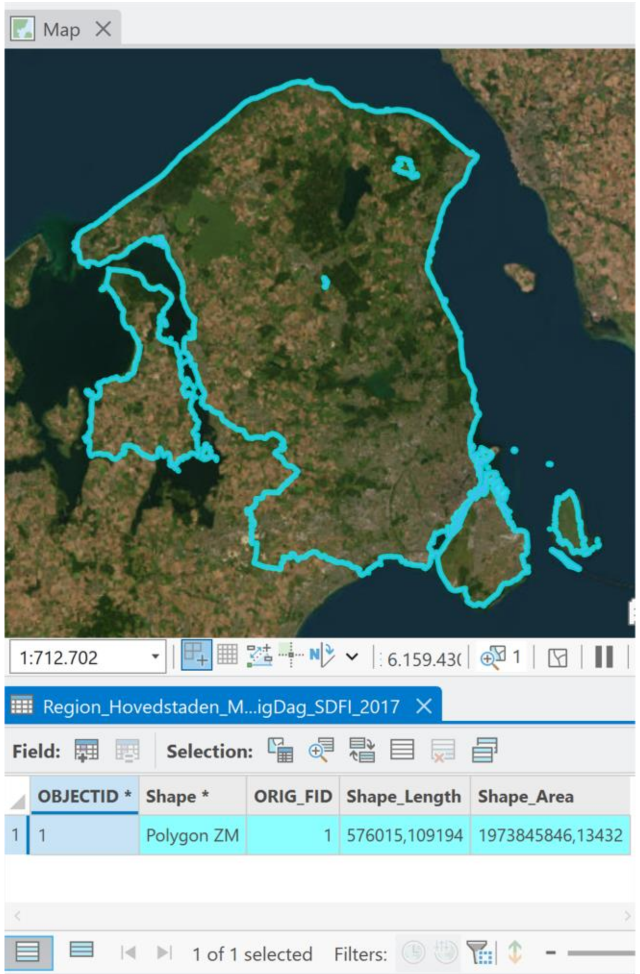


Fig. 3 The Region Hovedstaden multipart feature.

Exercise

To reduce your study to the Region Hovedstaden area, you will use this layer as the template, or 'cookie-cutter', to extract this particular area from the 'dough' - the nationwide *SurfaceWater_100m_Weighted_1_10* layer.

Clip Raster tool

In a previous exercise, you have encountered a very similar geoprocessing operation – a Clip.
Then, you used a Clip tool on a vector dataset.
Conveniently enough, there exists a corresponding tool for raster datasets – the Clip Raster tool.

Use your skills

6. a) Find the Clip Raster tool in the Geoprocessing pane.

By this stage of the course, you have been presented to quite a few ArcGIS Pro tools.
You have probably noticed that they follow a similar procedure with some standard elements:

Input Dataset
+
Parameter settings
+
Output Dataset

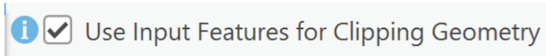
i) For example, you always need one or several Input datasets.

ii) Then, for your Output dataset, you need to select a destination where it is going to be stored (a folder or a geodatabase), and to type a name for it.

iii) In between, you may need to set some extra parameters.

b) In the Clip Raster tool, select and/or fill out the necessary details for the Input Raster, Output Extent and the Output Raster Datasets.

c) For this particular Clip Raster operation, you also only need to pay attention to one extra parameter:
Check the Use Input Features For Clipping Geometry checkbox.



(You may always hover over the to read why activating this may be a good idea.)

You will find this icon next to all the settings of a tool.
If you hover the pointer over it, some useful info about this setting is displayed.

d) Click Run.
Take a look at the automatically added output in the Map View (Fig. 4).

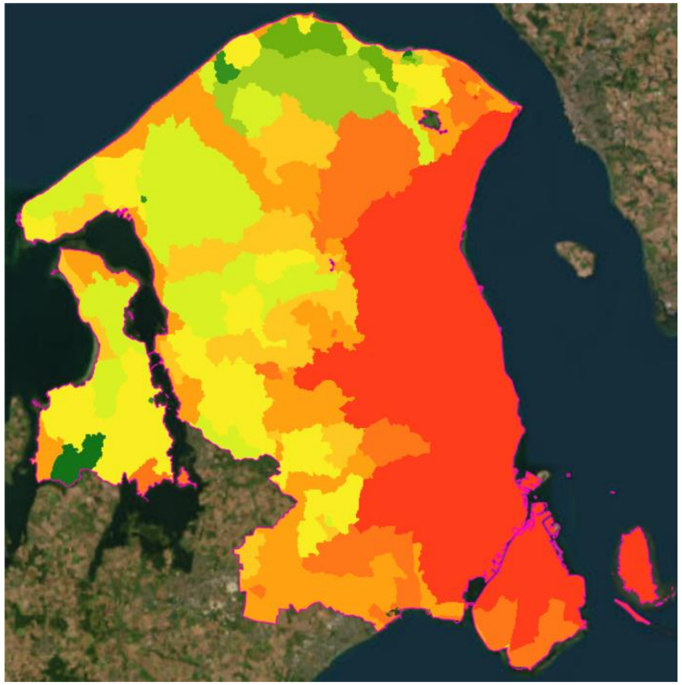


Fig. 4 The Surface water runoff raster layer clipped to the extent of the Region Hovedstaden.

Exercise

Next, we are going to introduce yet another geodataset, which was used for this particular study.
This dataset is representing 'accessibility' to a new forest,
by people who would like to use the forest
as a source for outdoor recreation and restitution.
We do have evidence-based research at this institute,
showing that nature and nature-based therapy (NbT) is positive
for your well-being and your ability to recover from stress.

The Accessiblity layer was developed by Hans Skov-Petersen, professor at the IGN

7. Add the *Accessibility_100m_Weighted_1_10_RegHovedstaden* raster dataset to the Map View (Fig. 5).
(It has already been clipped for you.)

Let's study and interpret this layer.
In the legend, notice that the pixel values stretches from 3 to 10.
Originally, the range scaled 1-10 for the whole country.
But for this region, there were no 1- and 2-value pixels, apparently.

We may also notice that there are relatively many high-value pixels
closer to Copenhagen (Fig. 5, darker green pixels).
This tells us that, according to this layer alone, it is most beneficial
to plant forest closer to this densely populated area.

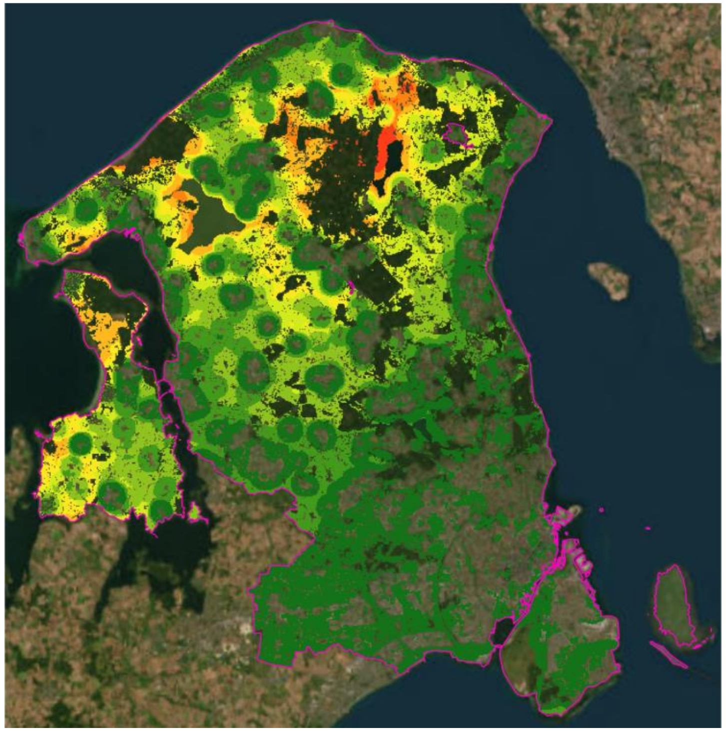


Fig. 5 The Accessibility raster layer clipped to the extent of the Region Hovedstaden.

So, is this because there is more infrastructure in this area, which would increase the accessibility to a new forest?
This could be one way to put it, but this is not the true story of this layer.
What this layer represents, is how many people would be able to enjoy the positive effects, if a forest was planted in a certain location.
But, more importantly, the layer reflects to what extent people living nearby *already have access* to nature.
This is how to read this layer:

- When a pixel has a really high value (green colour), there are many people living closeby, AND currently they also have no/little access to nature.

Thus, this is a better pixel for afforestation, since more people with less nature access will gain the benefits of nature.
And the contrary is true for pixels with lower values (red):

- In those areas, the population is less dense, and they already have quite good access to nature.

Exercise

Next input variable to add is a geodataset representing the value of agricultural land.

The Agricultural Value layer was developed by Michael Friis Pedersen (Senior Advisor, IFRO) and Patrik Karlsson Nyed (GIS Consultant, IGN)

8. Add the *AgriculturalValue_100m_Weighted_1_10_RegHovedstaden* raster dataset to the Map View (Fig. 6).
   (This layer too has already been clipped for you.)

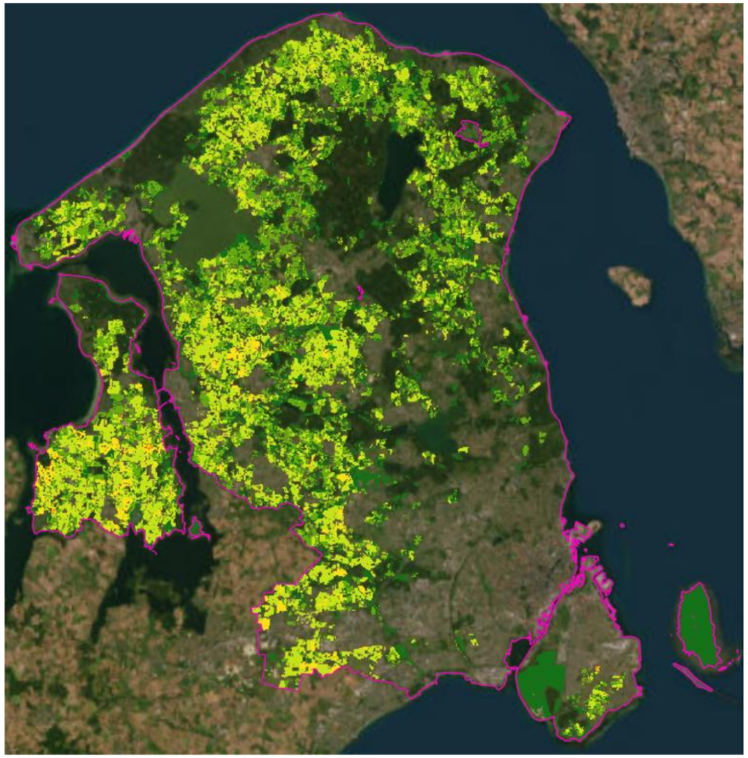


Fig. 6 The Agricultural Value raster layer clipped to the extent of the Region Hovedstaden.

You may notice that the range of values stretches from 5 to 10.
Again, this is a result of the clip operation.
Originally, the nationwide geodataset had values ranging 1-10.

The reason this geodataset was introduced to the research study, is that land types used for agricultural practices are an important candidate for afforestation.
There are various arguments for this, including:

- National economy
  The agricultural practices are getting increasingly more efficient (partly thanks to [GIS and precision farming](#) 😊).
  As a consequence, national economists predict a reduced need of agricultural land use surface in some parts of the world.
  Another argument is the increasing influx of cheaper imported agricultural products, which may outcompete Danish farmers.

Precision farming

- Lack of alternative available land types
  Urban areas are constantly growing, 'devouring' new land.
  Other 'empty' non-forested natural land types need to be preserved as they are, though, because they hold threatened species/ecosystems, or are essential for other purposes (*e.g.* recreation).

The way to read this layer (Fig. 6), is that the higher the value (darker green pixels), the lower the 'cost' to replace the agricultural land with forest.
This 'cost' is based on, for example the soil type and which crops have been cultivated in the most recent years.
A concrete example, a pixel on a good soil (*e.g.* clay) and where the farmer has been able to grow valuable and plenty of crops in recent years, will receive a low value (red pixels).
Consequently, for national economic reasons, you would like to find the opposite of this, to grow forest on.

Exercise

There were more input variables in this study.
However, for reasons of simplicity and time, we will only introduce one more.
The last one we will introduce is an 'exclusion' geodataset.

Exclusion area layer

9. Add the *ExclusionArea_100m_RegHovedstaden* raster dataset to the Map View (Fig. 7).
   (It has already been clipped for you.)

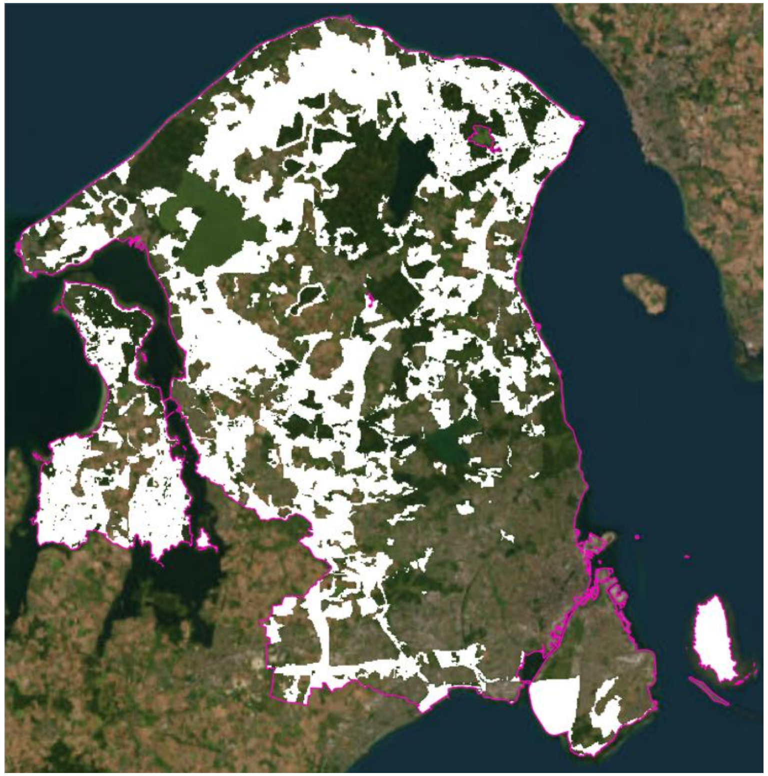


Fig. 7 The Exclusion raster layer clipped to the extent of the Region Hovedstaden.

In fig. 7 the layer is displaying rather vast areas with white pixels.
You may also notice that the pixel size is the same as the other input geodatasets presented above.

10. Zoom in, so that you may view the outline of a single pixel.
    You will discover that the edges of the pixel sides are aligning perfectly to the pixels of the other input geodatasets.

Aligning/Snapping the pixels of raster datasets will be described later.

Aligning/snapping of input raster datasets is often a necessary operation to increase your control over the data quality (Fig. 8).

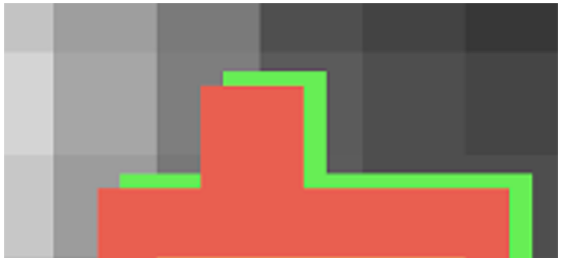


Fig. 8 Three overlapping raster layers, but with poor alignment of pixels.

The exclusion layer is inverted.
That is, you will need to interpret the white pixels as land areas where the municipalities, in their plan documents, have decided that planting of forest is in fact *'desirable'*
(All the transparent pixels represent the *un*desirable areas.).
Some criteria for excluding afforestation are land with landscape, geological, culture historical or biological values.
Or, for purposes of urban development, like road construction.
So, instead of receiving low values for undesirable pixels in an input geodataset, those pixels will be exempt from the overlay analysis in the Suitability Modeler altogether, by introducing this exclusion layer.

Exercise

Suitability Modeler

At last, now we will continue with the fun stuff – running the analysis in the Suitability Modeler.

11. a) In the Main menu, select the Analysis tab.

b) On the Analysis ribbon, click the Suitability Modeler button.

The Suitability Modeler pane appears along the far right edge (Fig. 9).

3 steps:
- Settings
- Suitability
- Locate

The Suitability Modeler pane is principally a 3-stage-rocket,
where we need to complete some tasks at each of the three tabs
Settings, **Suitability** and **Locate** (Fig. 9a-c).

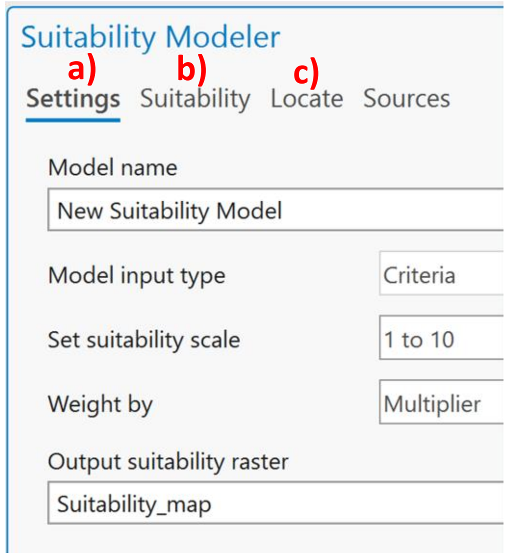


Fig. 9 Three steps of the Suitability Modeler a) Settings, b) Suitability and c) Locate. Here, the Settings tab is presented.

1. Settings tab

12. a) We will accept all the default settings in the 'Settings' tab (Fig. 9a)

- Model Name: You may, if you like, type your own name.
- Set Suitability Scale: '1 to 10'
  We have already prepared each of the input geodatasets,
  so that the values of the pixels range from 1 to 10.
- Output Suitability Raster: You may, if you like, type your own name.
  By default, the output raster will be saved in the project geodatabase.

Now, we are done with the 1st step and will move on to the 2nd step:

2. Suitability tab

13. a) Select the Suitability tab (Fig. 9b)

In the Suitability tab (Fig. 10), we will add all the input geodatasets,
which we would like to use for our model, so that we may highlight
the most optimal sites for afforestation in the Region Hovedstaden area.

b) Click the  button in order to select and add raster layers to the model.

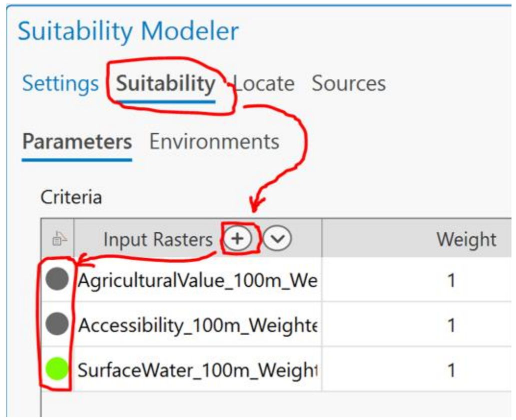


Fig. 10 The 2nd step of the Suitability Modeler – the Suitability tab.

Exercise

Suitability Modeler (cont.)

***2. Suitability tab** (cont.)*

13. c) (Optional) Set a new Weight (e.g. 1,2,3…10,20) to any of the layers (Fig. 10, previous page).

This is a way to elaborate with the ‘importance’ of each of the layers.
For example, let´s say that you reconsider one of the input layers, and estimate its significance as double that of the other the input layers. Then you have an option to set this layer´s weight to 2.

d) ‘Activate’ the layers by clicking the circles next to a layer. For each layer activated, it will turn light green (Fig. 10).

Group layer

Notice that, at the same time as we are adding layers in the Suitability Modeler pane, there will also be added a Suitability Model group layer in the Contents pane (Fig. 11a, **green** box).

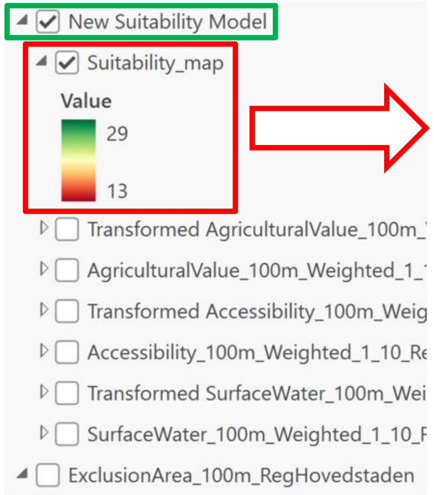
In this group layer, the actual input layers are added (+ an additional layer representing the transformed version.)

Suitability Map

At the top of the stack is a new layer called ‘Suitability_map’ (Fig. 11a, **red** box), shown in the Map view (Fig 11b).
This is the amalgamation of all the input raster layers.
In the legend you will see the range of values when all pixels of the input layers have been added together.
In this case, the value range is 13-29.
This means that no single pixel location had an aggregated maximum sum of 30 (3 x 10), but very close (10+10+9).

Already from the Suitability Map you may sometimes be able to determine certain areas with a cluster of high-value pixels.

These are strong candidates for suitable sites, but the final result depends on other criteria too, which will be presented in a moment.



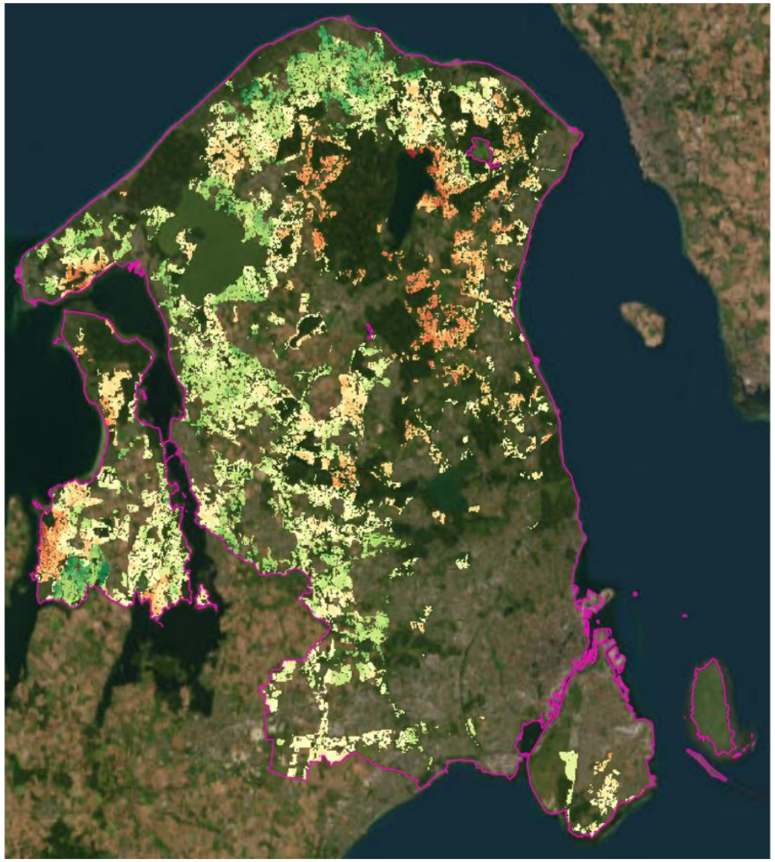


Fig. 11 When ‘activating’ the input layers, a group layer is created in the Contents pane.
a) The input layers turn up inside the group layer, together with the Suitability Map layer.
b) The Suitability Map layer may be studied in the Map view.

Exercise

Suitability Modeler (cont.)

***2. Suitability tab** (cont.)*

You probably also noticed that a Transformation pane opened at the lower edge of the Map view (Fig. 12).
We will not go into deeper details about the use of Transformation pane here, but only mention a few things.

You probably recall that we clipped the nationwide geodatasets.
We did this to narrow our study down to the Region Hovedstaden area.
In that process, the original range of values (1-10) was reduced for some of the input geodatasets.
For example, in the Agricultural Value layer, the range of pixel values became only 5-10.
Unfortunately, the Suitability Modeler may distribute those 5-10 values a little differently along a 1-10 scale.

Transformation pane

Troubleshoot ➔➔➔➔➔
If it is difficult to read, you may dock the Transformation pane to another location.

14. a) In the Suitability Modeler pane (the Parameter subtab), click the circle of an input raster geodatasets.

This way, this layer will be activated and displayed in the Transformation pane (along the lower edge).

In the Transformation pane, middle section (Fig 12a), we may view how the Suitability Modeler may have distributed the Suitability values <u>differently from</u> the true pixel values (shown in the Category column).

b) If you disapprove with this, you may change/edit them back to their original values (Fig 12a).

c) Do the same check with the remaining layers.

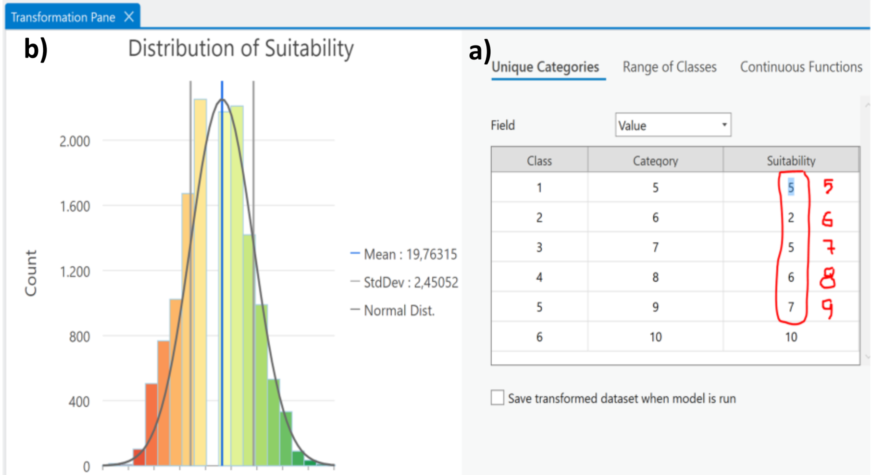


Fig. 12 The Transformation pane, where you:
a) In the mid section, may edit the Suitability values.
b) In the left section, may view the distribution of Suitability valu

A distribution shows how many times a certain value is present.

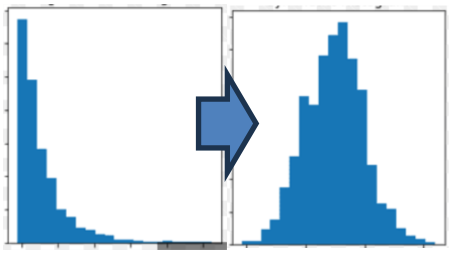


Fig. 13 A highly skewed distribution mathematically transformed into a normal distribution.

The second thing we would like to mention about the Transformation pane is *distributions.*
The values of geodatasets may display various distributions.
Quite many phenomena in the real world display a bell-shaped, normal distribution (Fig. 12b, left section).
For some input variables, the distribution may look different (See Transformation pane, right section, not shown here).
They may be highly skewed, for example with almost all values at the lowest end, and almost none with higher values.
In such an extreme case with low variation, you may consider if it would be useful to include the geodataset at all, because it would actually not change the output model very much.
Another approach to such a situation is to artificially change the distribution of the values, for example to make them more similar to a normal distribution (Fig. 13).
You may accomplish such a transformation operation in the Transformation pane (This will not be explained in detail here).

Exercise

Suitability Modeler (cont.)

***2. Suitability tab** (cont.)*

Before we leave the Suitability tab of the Suitability Modeler pane, we have one thing left to do – we will include the exclusion geodataset in our model.
That is, we are going to 'tell' the Suitability Modeler tool, that it should not consider any areas, which the municipalities had decided were undesirable for afforestation, according to their plan documents.

Exclusion geodataset

15. In the Suitability Modeler pane, and on the Suitability tab, switch to the Environments sub-tab (Fig. 14).

As you probably remember from before, the Settings tab of a geoprocessing tool always has a lot of options.
Here, we will only focus on the Mask and Snap Raster parameters.

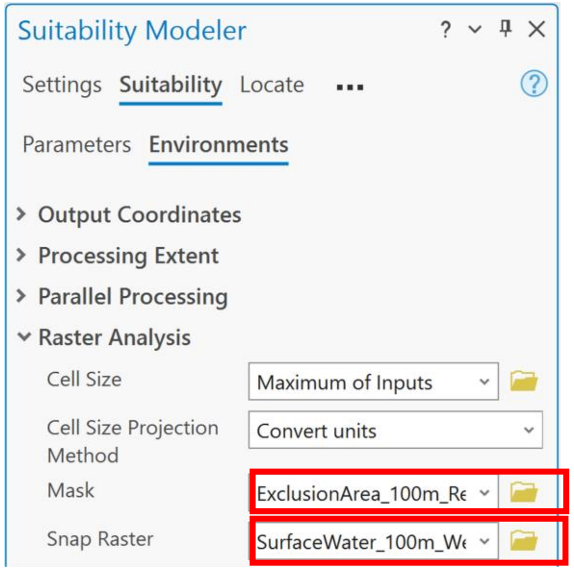


Fig. 14 In the Suitability tab, and under the Environments sub-tab, you may define the input layers for Masking and Snapping.

16. a) Mask: Select the *ExclusionArea_100m_RegHovedstaden* layer (Fig. 14).

Mask

By defining the Mask parameter we are entering the exclusion layer into the Suitability Modeler.

Snap Raster

b) Snap Raster: Select one of the other input raster layers.

This action means that the Suitability Map will align with the pixels of the input raster layers.
(Recall what was discussed earlier on page 8 and shown in figure 8.)

Now, we are done here and may move to the 3rd and final stage – the 'Locate' tab.

3. Locate tab

17. In the Suitability Modeler pane, select the 'Locate' tab.

Again, a whole range of options is displayed (Fig. 15, next page).
Here is where you are going to decide what kind of model output you would like to have., like:

- How much land in total, would you like to find for potential afforestation?
  (Which is a very valid question, because you may estimate how much CO_2 will be sequestered.)
- Should it be one large area, or should it be divided into several smaller?
- What about the shape of the area?

Exercise

Suitability Modeler (cont.)

***3. Locate tab** (cont.)*

18. There are many many options in the Locate tab, but we will focus on the following (Fig. 15):

a) Total Area: Type a number.

b) Area Unit: Select a unit.

Those two parameters decide how large area the Suitability Modeler will present as most suitable.

c) Number Of Regions: Type a number.

Here, you decide whether the total suitable area will be one large, or divided into a number of smaller subareas.

d) Region Shape: Select a shape.

e) Shape/Utility Tradeoff (%): Type a number.

Sometimes the Shape parameter may be of interest, but if the shape of the suitable area (*e.g.* 'Circle') is unimportant to you, you may set Shape/Utility Tradeoff (%) to '0'.
By doing so, the selected Shape will be over-ruled, meaning that the suitable area may take any form.

f) Evaluation Method: Select one of the mathematical criteria.

Notice the 'Core Area' and the 'Edge Length' options, which may be desirable outputs in ecological studies.

g) Output Raster: Type a name.
(It will be saved in your project geodatabase by default)

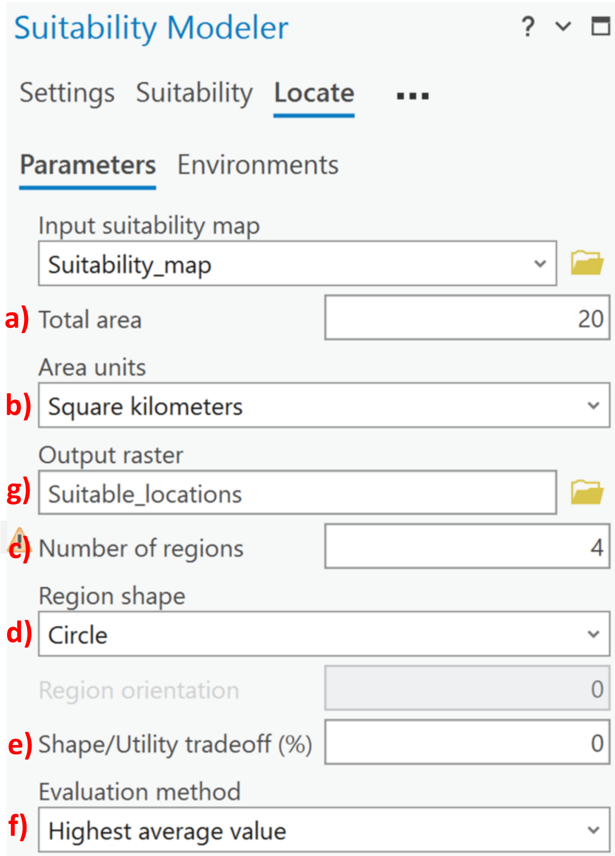
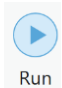


Fig. 15 In the Locate tab you may define the size, shape, number and evaluation method for the suitable sites.

Finally, we´re there, and we may run our model!

19. On the Suitability Modeler ribbon, you may press the Run button.



The Suitability Modeler starts geoprocessing. Notice how fast it will generate the output.
In very short time you will receive an output raster layer in the Contents pane.
-Quite powerful, considering the complexity of the operation! 😊

Exercise

Suitability Modeler (cont.)

20. In the Contents pane, turn on the newly generated ‘Suitable Locations’ layer, that was added automatically (Fig. 16a).

The ‘Suitable Locations’ layer is displaying the best location areas for afforestation within the Region Hovedstaden, consistent with the input geodatasets we used in this model and the parameters we specified.

Suitable Locations layer

In the Map view, you may see the locations as a collection of connected pixels of one colour (Fig. 16b).
In the Contents pane, they are described by a number and the corresponding colour in the legend (Fig. 16c).
You will also notice a much larger, one-coloured area denoted ‘0’ (gray colour in Fig. 16a-c).
This is the rest of the potential area, which was assessed in this model, but was not selected as a best location.

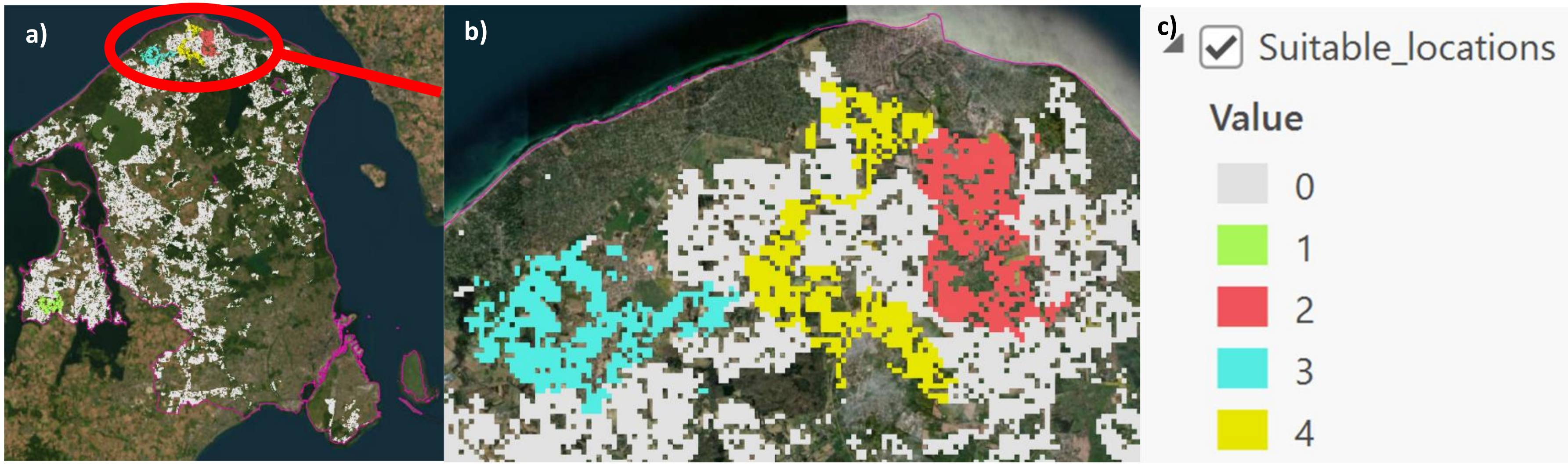


Fig. 16 An example of the output of the Suitability Modeler.
a) The entire Region Hovedstaden area, with the 4 sites suitable for afforestation are highlighted in red, yellow, green and blue. The gray pixels represent the remaining areas, which were considered, but not chosen as suitable sites.
b) A magnification of the northern part of Region Hovedstaden, with 3 suitable sites (red, yellow and blue).
c) The legend of the output Suitability Locations layer.

Are we done now?
- Perhaps

If you are considering using raster datasets in your Project, please continue to the next page.

A few final remarks on the output of this model run:

- In figure 16b, you may notice that the elongated shape of some best locations. This is the result of us selecting a shape (*e.g.* ‘Circle’), but at the same time setting another parameter to allow for the output to take any kind of shape.

- Also, in figure 16b, you may notice that the best locations are bordering each other. If you would like them to be further apart from each other, there is a parameter setting for this too.

Exercise *Preparation of raster input geodatasets*

Preparation of raster

The procedure described above may seem quite easy and straightforward.
- Just collect a few pre-made geodatasets, and then plug them into the Suitability Modeler.
To tell you the truth, it´s not that easy, but not extremely complicated either.

To bring some clarity, we will mention a few geoprocessing operations, that led to this collection of input geodatasets.
We cannot describe all of those operations in detail in this exercise, but we will introduce a few of them briefly:

Vector → Raster format

1. Vector to Raster conversion

It is not uncommon that some of the input variables that you would like to use, may be available only in vector format.
Then you would need to convert the vector geodataset into a new geodataset in raster format (Fig. 17).

Feature To Raster tool

Polygon To Raster tool

ArcGIS Pro offers various tools, like the Feature To Raster or the Polygon To Raster tools.

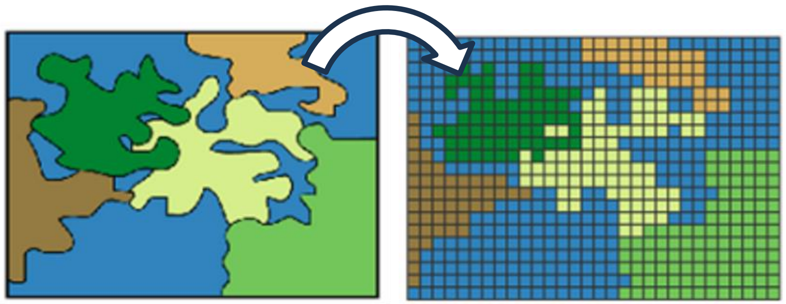


Fig. 17 The conversion of a geodataset in vector format to a corresponding geodataset in raster format.

Resampling rasters

2. a) Resampling of raster geodatasets

A raster overlay operation works best when the input raster geodatasets are of the same resolution. That is, they have the same pixel size.
If they are not, a raster overlay operation may still work, but the geoprocessing will take longer time.
More importantly, you may lose control over data quality, because the GIS software will recognize the ‘mismatch’, and will try to ‘adjust’ the pixel values, using an algorithm that may be unknown to you.

Resample tool

ArcGIS Pro offers the Resample tool to change the pixel size of a raster geodataset.
N.B. The Resample tool too *will* induce loss of data quality.
The big difference is that you have the control, not the computer.
You may for example decide for yourself, which resampling algorithm that you would like to use.

A few examples of resampling algorithms:
- ***Majority***
- ***Nearest***
- ***Bilinear***
- ***Cubic***

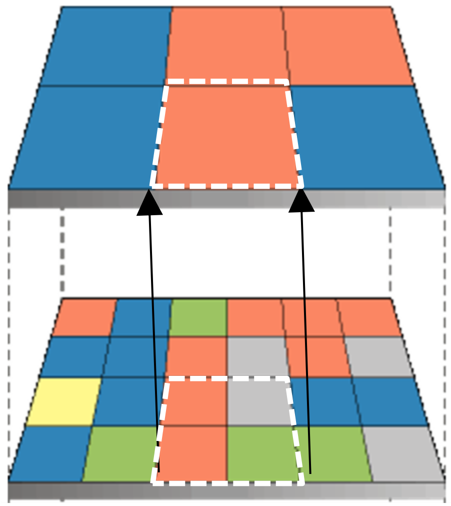


Fig. 18 Resampling of a raster layer of higher resolution (below), to a layer of lower resolution.

N.B. If you resample from lower to higher resolution (*e.g.* 100m to 25m), <u>no</u> data quality loss will occur. However, you will not gain any data quality either, and you will end up with a much larger dataset (16x heavier), which may have adverse implications on geoprocessing time and storage.

Exercise

Preparation of raster input geodatasets (cont.)

Preparation of raster

2. b) Aligning/snapping of raster geodatasets

Similar to using raster geodatasets with the same pixel sizes, it is an advantage if the rasters all 'line up' perfectly.
That is, the borders of pixels in one input raster geodataset ought to align with the corresponding pixels in the other input raster geodatasets.

If there is mis-alignment between raster layers in a raster overlay operation, this may result in calculation errors because it is not conclusive if a pixel of one layer 'belongs to' either of the four partly overlapping pixels (Fig. 19).

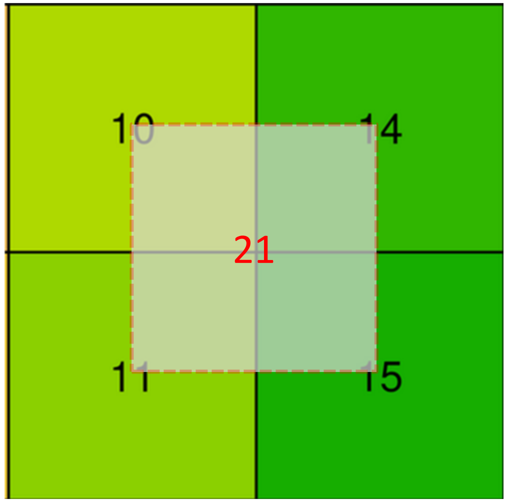


Fig. 19 Mis-alignment of two raster layers with the same pixel size. The pixel of the gray transparent layer overlaps partly with the pixels of the green raster layer.

Snap Raster

ArcGIS Pro offers the Snap Raster parameter in the Settings of any raster tool.
This is a way to ensure that you end up with raster geodatasets, that are perfectly aligned to each other.

During the snapping operation, the cells will be shifted/pushed in space in line with the pixels of the template raster (Fig. 20).

3. Reclassification

In this exercise, all input variable raster geodatasets had a value range of 1-10.
The raster geodatasets in your Project will most certainly have other values.
In that case, you may consider if those values shall be used in the mathematical expression of your overlay operation, or whether the values ought to be re-scaled to 'relate' better with the other input variables.
The risk is else that a layer with a value range of 1-500 might have more weight in the output compared with a layer with a value range of only 1-10.
Input layers with different 'weights' may be justified, but if not, you will need to normalize the value ranges to the same scale (*e.g.* 1-10).

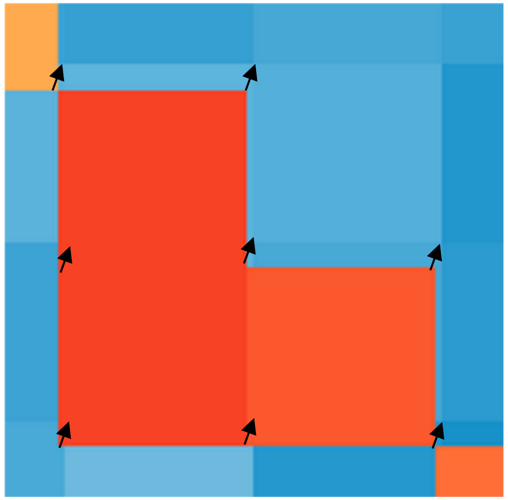


Fig. 20 Snapping of the cell borders of the red raster layer to the cell borders of the blue template raster layer.

Reclassify tool

ArcGIS Pro offers the Reclassify tool, which is one way to change the values in a raster geodataset to some new values.

**N.B. Remember that reclassification results in loss of data quality.
If you go from a value range of 1-500 to 1-10, some of the data resolution will be lost.
Furthermore, your choice of reclassification boundaries will be subjective.**

Thanks for your attention!