



# **Handbook**

for tools in Dasymetric toolbox for ArcGIS Pro

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## Introduction

The main goal of the diploma thesis was to create a set of tools to automate aggregation and disaggregation methods in the ArcGIS Pro environment. All tools were created in Python version 3.6.9 and are part of the Dasymetric.tbx toolbox. The created toolbox is downloadable on the thesis website and is also available as a part of Appendix 7 (DVD) of the thesis.

The issues of aggregation and disaggregation methods differ from each other. Both analytical methods require different processing techniques and different input parameters, so it was not possible to implement both methods into one tool. A total of six tools were created as an output of the thesis. Two tools are meant for aggregation, two for disaggregation and two for creating ancillary data layer. The created tools, including their parameters and the functionality principle, are described on the next pages of this handbook.



Fig. 1: Toolbox Dasymetric.tbx

## Table of Contents

Introduction.....	2
Aggregate Features To Polygon .....	3
Aggregate Polygon To Polygon.....	5
Create Raster Ancillary Layer .....	7
Create Vector Ancillary Layer .....	9
Disaggregate Polygon To Polygon – Raster Version .....	11
Disaggregate Polygon To Polygon – Vector Version.....	13

## Aggregate Features To Polygon

The Aggregate Features To Polygon tool allows you to aggregate input vector data into target polygon zones. The input data to this tool can be point, line or polygon, the output is a new polygon layer with aggregated attributes.

### Tool Parameters

Aggregate Features To Polygon tool requires four input parameters, all of them are required.

Tab. 1: Aggregate Features To Polygon - input parameters

Parameter	Explanation	Data Type
Source Layer	Input point, polyline or polygon feature to be aggregated	Feature Layer
Target Polygon Layer	Target polygon layer for which the source layer will be aggregated	Feature Layer
Summary Fields	Field – one or more fields whose value will be aggregated. Fields must be of numeric data type (short, long, float, double), other values are not supported  Statistic – type of calculated statistics for each given field (sum, average, standard deviation and minimum and maximum value can be calculated)	Value Table
Output Feature Class	Name and location of the new polygon layer with aggregated data	Feature Class

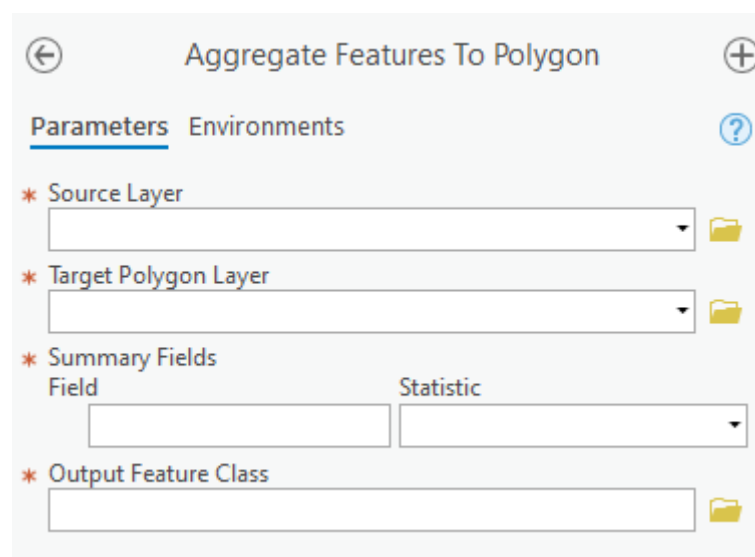


Fig. 2: Aggregate Features To Polygon tool

### Functionality principle

The functionality of the tool is based mainly on the Summarize Within tool. The Summarize Within script is included as part of the Analysis toolbox and is available with the basic ArcGIS Pro license. The Summarize Within tool allows to work with all basic geometry types. Its advantage is the ability to aggregate multiple attributes at once and select the calculated statistics for each of them separately. However, only numeric attributes can be aggregated, other data types are not supported.

Point, polyline, or polygon data enter the Summarize Within tool along with the target polygon layer. For the desired attributes, selected statistics are calculated for the target zones and the output is saved as a new polygon layer. The functionality principle of the tool is indicated in Fig. 3.

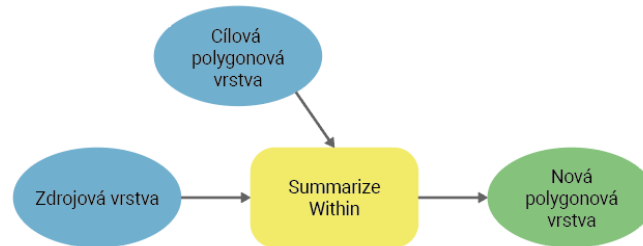


Fig. 3: Aggregate Features To Polygon – tool workflow

### Suitable usage examples

- Point data aggregation to polygon (address points, sensor measurements,...)
  - number of flats in the area of interest
  - average number of floors of houses in the area of interest
  - highest / lowest temperature within an area
- Polyline data aggregation (road network, watercourses, power lines) into polygons
  - road network/watercourse length in given area
- Polygon data aggregation
  - aggregation of informations about buildings in area of interest
  - aggregating number of inhabitants to coarser spatial units

### License

- Basic: Yes
- Standard: Yes
- Advanced: Yes

## Aggregate Polygon To Polygon

The Aggregate Polygon To Polygon tool is used to aggregate input polygon data into target polygon zones. Unlike the previous tool, it only works with polygon input data. The tool does not allow aggregating multiple attributes at once and it supports only the calculation of SUM and MEAN statistics. However, the advantage is the possibility of choosing the type of input variable and the output does not consume lots of disk space.

### Tool Parameters

The Aggregate Polygon To Polygon tool has six input parameters, the first five of them are required and the last one is optional.

Tab. 2: Aggregate Polygon To Polygon input parameters

Parameter	Explanation	Data Type
Source Zone	Source polygon layer containing the attribute desired to be aggregated.	Feature Layer
Target Zone	Target polygon layer to which the aggregation will be calculated.	Feature Layer
Aggregation Field	Aggregated attribute from the source zone. After selecting the source zone, the list of allowed fields will be available.	Field
Output Field Name	Name of the newly created field in the Target Zone layer that contains the aggregated values	String
Variable type	Input variable type: <ul style="list-style-type: none"> <li>EXTENSIVE – an extensive variable typically expresses count or sum data type (number of inhabitants)</li> <li>INTENSIVE – intensive variable typically expresses proportions or rates (unemployment rate, average age)</li> </ul>	String
Aggregation Type (optional)	Type of calculated statistics for the Aggregation Field. This parameter is displayed only if an extensive variable is selected. The parameter allows two values: <ul style="list-style-type: none"> <li>SUM – sum of the values of the aggregated field within the target zone</li> <li>MEAN – average of the values of the aggregated field within the target zone</li> </ul>	String

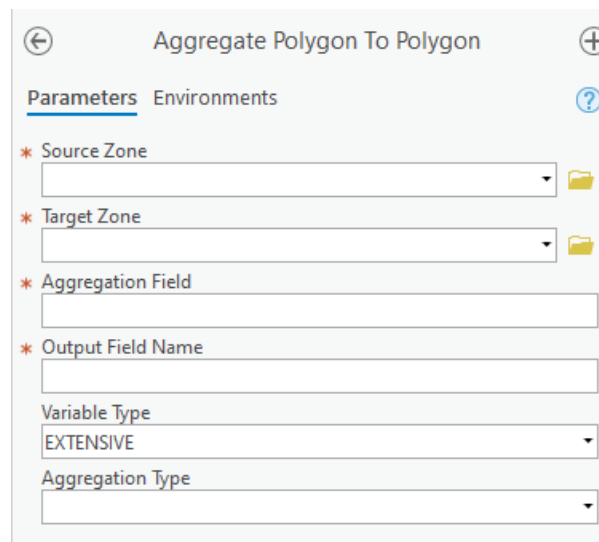


Fig. 4: Aggregate Polygon To Polygon tool

### Functionality principle

The principle of the tool is based on polygon overlay and the areal weighing method, because in some cases of aggregation tasks the target zones may overlap the source zones (eg aggregation from buildings to hexagon grid). In this case, the source zones would be divided into two target zones during the polygon overlap and the aggregated attribute would remain unchanged, thus being counted more than once in result. The Intersect tool was used for the polygon overlay, because it retains only the places with the occurrence of both zones. This is useful especially if the source zones do not completely cover the target zones. Finally, all temporary layers are deleted and the only output of the tool is one new attribute in the target zone. The functionality principle of the tool is indicated in Fig. 5.

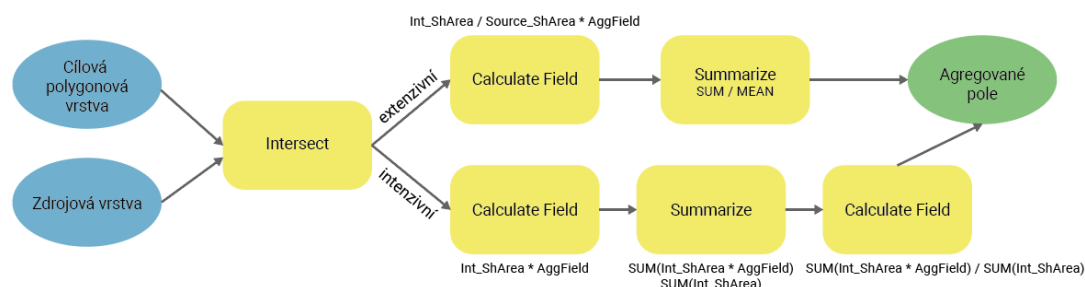


Fig. 5: Aggregate Polygon To Polygon – tool workflow

### Suitable usage examples

- Aggregating polygon data to polygons
  - aggregating the number of inhabitants or the number of flats in the area of interest
  - calculation of the average age of the population in coarser spatial units
  - calculation of the average unemployment rate in higher territorial units

### License

- Basic: Yes
- Standard: Yes
- Advanced: Yes

## Create Raster Ancillary Layer

The Create Raster Ancillary Layer tool is designed to create an ancillary data layer entering the disaggregation process. The ancillary data layer is used in disaggregation techniques to explain the spatial distribution of the phenomenon. The use of the raster disaggregation tool is not conditioned by the use of this tool. However, if it is desired to create a raster ancillary layer from vector data, it is appropriate to create raster ancillary data layers using this tool. The raster version of the tool supports point, polyline and polygon input data. The output from a this tool is one or more rasters according to the number of input attributes.

### Tool Parameters

The raster version of the tool has five input parameters, two of them are mandatory and three are optional. Before running the tool, it is advisable to make sure that all input polygon layers contain an attribute with the weight of every feature.

*Tab. 3: Create Raster Ancillary Layer – input parameters*

Parameter	Explanation	Data Type
Participating Layers	Vector layers from which raster ancillary data layers will be created. This parameter allows to select multiple vector layers at once and consists of two parts: <ul style="list-style-type: none"> <li>Input Vector Layer – input vector layer that will be converted to raster</li> <li>Selected Field – selected field of numeric data type, values in this field will be stored as a raster value</li> </ul>	Value Table
Output Workspace	The target workspace in which the output rasters will be saved. The name of the created raster is the same as the name of the converted field (Selected Field)	Workspace
Output Cell Size (optional)	The cell size of the created rasters. The unit of cell size is determined by used coordinate system. The default value is 5.	Double
Coordinate System (optional)	Coordinate system in which the resulting raster will be created. The default value is the coordinate system of current Project.	Coordinate System
Ancillary Layers Extent (optional)	Allows to select the extent of the created raster layers	Extent

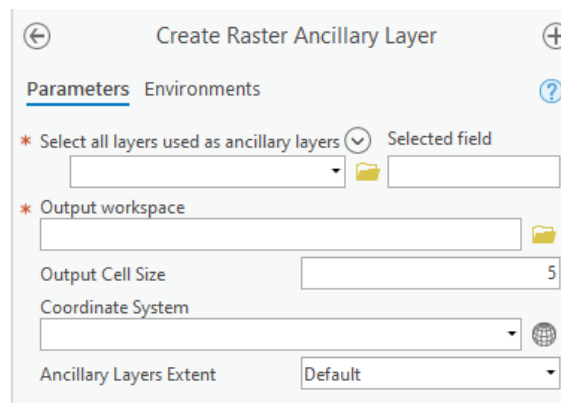


Fig. 6: Create Raster Ancillary Layer tool

### Functionality principle

The raster version of the tool works on the principle of converting vector data into a raster. First, the working directory, extent, coordinate system and raster cell size are set using user-defined parameters. If the Output Coordinate System parameter is not filled in, the script will use the coordinate system of current map. All selected layers are then converted to raster and the values of the selected attribute are used as the raster value.

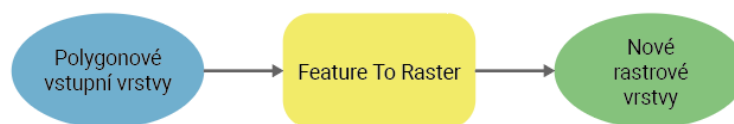


Fig. 7: Create Raster Ancillary Layer – tool workflow

### Suitable usage examples

- Conversion of vector ancillary data layers to raster for their use in the raster version of disaggregation

### License

- Basic: Yes
- Standard: Yes
- Advanced: Yes



## Create Vector Ancillary Layer

The Create Vector Ancillary Layer tool is intended to create an ancillary data layer entering the disaggregation process. The ancillary layer is useful for disaggregation to explain the spatial distribution of the phenomenon. The use of a vector disaggregation tool is not conditioned by creating an ancillary layer using this tool, but if it is necessary to use more complex ancillary data (combination of at least two or more vector layers), it is appropriate to create an ancillary layer using this tool. The vector version of the tool allows only polygon data on its input, as the output is one new polygon layer created.

### Tool Parameters

The vector version of the tool requires only two mandatory input parameters. Before running the tool, it is advisable to make sure that all input polygon layers contain an attribute with the weight of each feature.

Tab. 4: Create Vector Ancillary Layer – input parameters

Parameter	Explanation	Data Type
Participating Layers	Vector layers from which a new ancillary layer will be created. The parameter allows to select multiple vector layers at once.	Feature Layer
Output Ancillary Layer	Name and storage location of the new polygon ancillary layer	Feature Layer

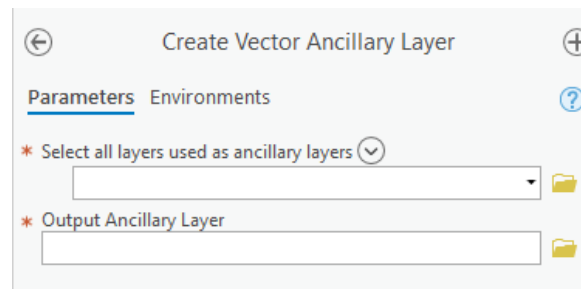


Fig. 8: Create Vector Ancillary Layer tool

### Functionality principle

The vector version of the tool works on the principle of polygon overlay. In order to create a unique combination of all input layers, the Union tool was used, because it preserves all input elements and their attributes. The resulting layer is then saved under the selected name in the selected directory.

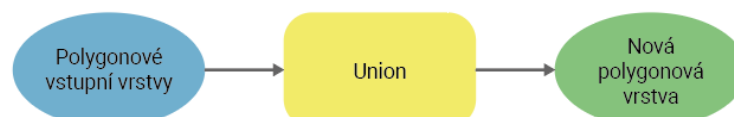


Fig. 9: Create Vector Ancillary Layer – tool workflow

**Suitable usage examples**

- Combining multiple vector layers of ancillary data into one for its use in the vector variant of disaggregation

**License**

- Basic: Limited (max 2 vector layers at once)
- Standard: Limited (max 2 vector layers at once)
- Advanced: Yes

## Dissagregate Polygon To Polygon – Raster Version

Disaggregate Polygon To Polygon was created as a multifunctional tool to automate the areal interpolation, disaggregation and dasymetric mapping methods. The raster version of the Disaggregate Polygon To Polygon tool was created to disaggregate the value of a phenomenon from vector source zones to vector target zones with optional use of raster ancillary layer. The tool allows to select the type of calculated variable and performs the conversion for only one attribute at a time. The output of the tool is one new attribute in the attribute table of the target zone, the other created data are deleted after the task is completed.

### Tool Parameters

The raster version of the tool has a total of seven parameters on input. The first five parameters are mandatory and the remaining two are optional.

Tab. 5: Dissagregate Polygon To Polygon (Raster version) – input parameters

Parameter	Explanation	Data Type
Source Zone	The source polygon zone containing the attribute for which the disaggregation will be performed	Feature Layer
Target Zone	Target territorial units to which the selected attribute will be disaggregated	Feature Layer
Disaggregated Field	The name of the field containing the values to be disaggregated	Field
Output Field Name	The name of the newly created field in the Target Zone layer, in which the recalculated values will be save.	String
Variable Type	Input variable type: <ul style="list-style-type: none"> <li>EXTENSIVE – an extensive variable typically expresses count or sum data type (number of inhabitants)</li> <li>INTENSIVE – intensive variable typically expresses proportions or rates (unemployment rate, average age)</li> </ul>	String
Output Cell Size (optional)	The cell size used in the conversion. The unit of this parameter is determined by the used coordinate system. The default value is 5.	Double
Ancillary Data (volitelný)	Allows to select multiple raster ancillary layers and determine their weights, it consists of two parts: <ul style="list-style-type: none"> <li>Ancillary Raster Layer – raster ancillary data layer</li> <li>Weight – weight the ancillary data layer</li> </ul> If this parameter is left empty, the data are recalculated using the areal weighing method.	Value Table

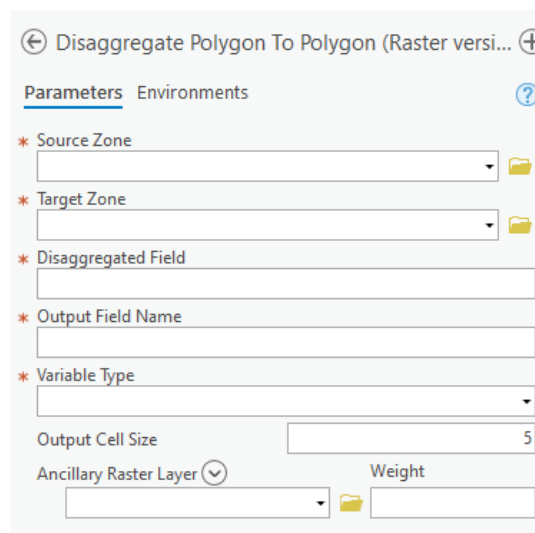


Fig. 10: Disaggregate Polygon To Polygon (Raster Version) tool

### Functionality principle

The functionality principle of the tool is based on map algebra language, it uses a set of Map Algebra functions for arcpy to calculate raster values. Map Algebra is part of the Spatial Analyst extension and is available under the Spatial Analyst or Image Analyst license. It is a set of functions, tools and operators for geographical analysis using rasters. After the calculation is completed, all temporary layers and rasters are deleted and the result is only one new field with disaggregated values in the Target Zone layer. The functionality principle of the tool is indicated in Fig. 11.

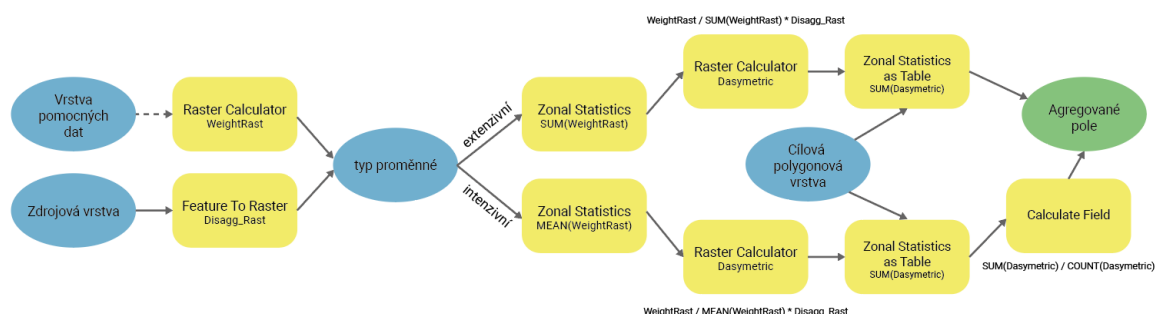


Fig. 11: Disaggregate Polygon To Polygon (Raster Version) – tool workflow

### Suitable usage examples

- Estimation of phenomenon values in lower or different territorial units using ancillary data layers
  - population disaggregation using nighttime lights or imperviousness rasters
  - areal interpolation of any phenomenon using the raster ancillary data layer

### License

- Basic: Requires Spatial Analyst or Image Analyst license
- Standard: Requires Spatial Analyst or Image Analyst license
- Advanced: Requires Spatial Analyst or Image Analyst license

## Dissagregate Polygon To Polygon – Vector Version

Disaggregate Polygon To Polygon was created as a multifunctional tool to automate areal interpolation, disaggregation and dasymetric mapping methods. The vector version of the tool Disaggregate Polygon To Polygon was created to disaggregate the value of a phenomenon from vector source zones to vector target zones with optional use of a vector ancillary data layer. The tool allows to perform disaggregation for only one attribute at a time. The calculation itself differs based on the selected type of disaggregated variable (extensive/intensive). The output of the tool is only one column in the attribute table of the target zone, the other temporary data are deleted.

### Tool Parameters

A total of seven parameters enter the vector version of the tool, five of them are mandatory and two are optional.

Tab. 6: Dissagregate Polygon To Polygon (Vector version) – input parameters

Parameter	Explanation	Data Type
Source Zone	The source polygon zone containing the attribute for which the disaggregation will be performed	Feature Layer
Target Zone	Target territorial units to which the selected attribute will be disaggregated	Feature Layer
Disaggregated Field	The name of the field containing the values to be disaggregated	Field
Output Field Name	The name of the newly created field in the Target Zone layer, in which the recalculated values will be save.	String
Variable Type	Input variable type: <ul style="list-style-type: none"> <li>EXTENSIVE – an extensive variable typically expresses count or sum data type (number of inhabitants)</li> <li>INTENSIVE – intensive variable typically expresses proportions or rates (unemployment rate, average age)</li> </ul>	String
Ancillary Layer (optional)	Point, polyline or polygon ancillary data layer. This variable is optional, so there is no need to specify ancillary data.  The tool allows the selection of only one layer of auxiliary data, if it's intended to use a combination of multiple layers, it is advisable to create a layer of ancillary data first.  If this parameter is left empty, the data are recalculated using the areal weighing method.	Feature Layer
Ancillary Data Fields (optional)	Allows to select multiple fields from the Ancillary Layer containing ancillary data weights. It consists of two parts: <ul style="list-style-type: none"> <li>Field – selected field containing ancillary data weights</li> <li>Weight – weight of the Field</li> </ul>	Value Table

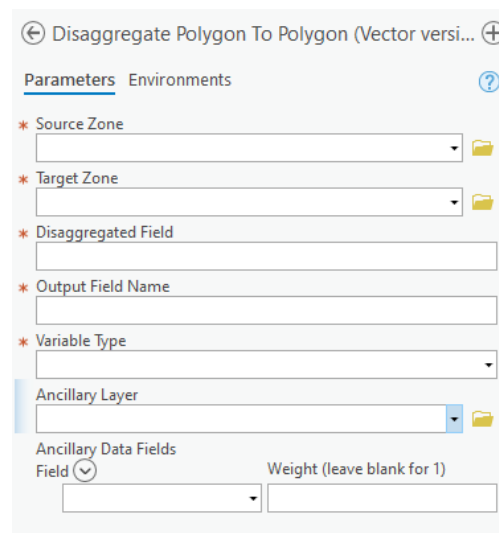


Fig. 12: Disaggregate Polygon To Polygon (Vector Version) tool

### Functionality principle

Functionality principle of the tool is based on the polygon overlay between the source zone, the target zone and the ancillary data layer (if provided). The Intersect tool was used for the polygon overlay. The output of the Intersect tool is a new polygon layer with geometry only in places where all layers overlap. Therefore, the calculation is performed only for areas in which the given phenomenon occurs. Compared to the Union tool, disk size and computational requirements are reduced. At the same time, attributes from all original layers are transferred to the new layer. When the calculations are completed, all temporary layers are removed and the output of the tool is only one new attribute in the target zone. The principle of functionality of the tool is indicated in Fig. 13.

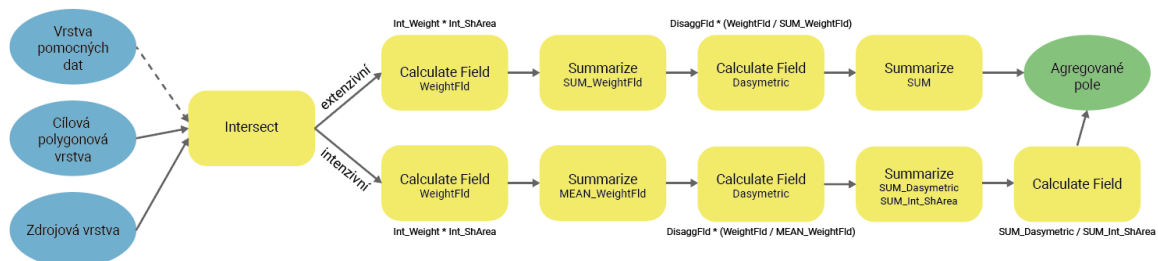


Fig. 13: Disaggregate Polygon To Polygon (Vector Version) – tool workflow

### Suitable usage examples

- Estimation of phenomenon values in lower or different territorial units using ancillary data layers
  - disaggregation of the population using address points, building footprints or vector landuse
  - areal interpolation of any phenomenon using a vector ancillary data layer

### Licence

- Basic: Limited (only without ancillary data layer)
- Standard: Limited (only without ancillary data layer)
- Advanced: Yes