

**URBAN
PLANNING**
TOOLS AS
AGENTS OF
CHANGE:

COLLABORATIVE
SPATIAL DATA FOR
SUSTAINABLE URBAN
DEVELOPMENT IN
INDONESIA

Technical Report:
Urban Hotspots

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2020

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Quick-start guide

Urban Hotspots is a Geoportal extension which simplifies the process of hotspots mapping and data analytics.

Using Urban Hotspots is straightforward:

1. Log in to the Geoportal.
2. Select Urban Hotspots from the Geoportal's Tools menu icon in the top right corner.
3. Select a study area.
4. Select which layers to include in the analysis and click "Evaluate".

You should see a hotspot map on the screen after a few seconds. The total computation time depends on the size of the selected layers.

Now, let's have a more detailed look at each step and describe all required inputs.

In the example above we have considered that data is already available at the Geoportal, and that someone has set up Urban Hotspots before. In the following section we will describe how to set it up from scratch.

To use Urban Hotspots you will need:

- A. Study area: A Geoportal layer which describes the study area for your analysis. Frequently this is a state, a municipality or a metropolitan area boundary. You can select any name for this layer, as long as it contains the string "study area".
- B. Layers: A set of Geoportal layers with data to be analyzed. Layers must have at least two attributes, one with the MMU (minimum mapping unit) identifier and one with the numeric values which will be mapped.
- C. Filters (optional): A set of Geoportal layers containing values of 1 or 0, which will be used for filtering data.

If these layers are not yet available in the Geoportal, upload them. Once that you have all layers in the Geoportal, follow these steps:

1. Log in to the Geoportal.
2. Select Urban Hotspots from the Geoportal's Tools menu icon in the top right corner.
3. Select the Geoportal layer that describes your study area.
4. Select "Advanced". From the layer panel select the layer that will be included in the analysis.
5. Match which attributes in the selected layer relate with the Layer value, and Minimal mapping unit ID.
6. Type a name for the layer. This will be the one displayed in the Urban Hotspots menu.
7. Click on "Save". Urban Hotspots is ready for analysis.

8. Optionally, select Filters or Settings from the “Advanced” section to add Filter layers or to modify weights and normalization options.

Normalization options include the following fields.

- a. Layer: Name of the layer in the Geoportal
- b. Normalization Method: Describes the method that will be used for normalization. Options include one of the following options: “Standardize” or “Benchmark”.
- c. Lowest value: The lowest value to process, when using the Benchmark method.
- d. Highest value: The highest value to process, when using the Benchmark method.
- e. Weight: A numeric value describing the amount in which each layer should contribute more than others to the final results.
- f. Smaller better?: True or false values, describing whether lower values should be considered optimal or not.

Dealing with messy data

You might need to use the “Clean data” icon at the mid-right of the Geoportal screen to perform basic cleanup operations to the Layer before importing to Urban Hotspots.

Euclidean distance calculator

If you have amenities-point or -polygon layers, you can use the “Advanced > Manage data > Evaluate distances” calculator to estimate euclidean distances to each MMU.

1.- Introduction

Cities around the world are facing big challenges due to accelerated population growth in urban settlements. These challenges include lack of infrastructure and urban services, access to quality public transportation, lack of resilience strategies to risk exposure due to natural disasters, etc. Typically, cities have several needs for infrastructure investment projects and public policies that improve socio-economic conditions, increase resilience and promote sustainable development. However, the budget is always limited. For this reason, it is very important to carry out a land suitability analysis that helps prioritize the most pressing urban concerns.

The main goal of this document is to describe the information used as inputs for the development and adaptation of the Urban Hotspots tool. We will describe the main sources of information and methods carried out by the CPL-CAPSUS team to create the required information.

In the Methodology section, we will go into deeper details about the tool, focusing on inputs and the calculation methods. Finally, we will give some conclusions about the data gathering process as well as some recommendations for the implementation in other cities.

2.- Methodology

2.1 Urban Hotspots

The Urban Planning Tool Urban Hotspots identifies optimal locations within a city for a specific activity by evaluating proximity between urban facilities and inhabitants, at local/ neighborhood levels across the city. It includes two search functionalities, the layer, and the filter, which correspond to indicators, planning standards, and national government's norms essential for spatial planning (population, employment, density, land use, etc.). These

functionalities grant flexibility to decision-makers, to explore multiple combinations of urban spatial planning parameters that capture and respond to the city's needs and challenges.

The following sections will focus on the calculation methods and inputs needed by the tool.

2.1.1 Inputs required

The Urban Hotspots tool needs a set of spatial and numeric data to perform its calculations. Regarding spatial data, the tool uses spatial information called “**Layers**” and “**Filters**”. Layers include georeferenced maps that represent a geographic area (town, city, etc.) where the land suitability assessment will happen, and a set of urban amenities georeferenced (public transportation, schools, hospitals, libraries, green spaces, worship places, markets, etc.).

Similarly to layers, filters are spatially georeferenced data representing certain areas/regions within the boundaries of a city. Filters act as a subset of a larger set (layer) and represent special areas within a city (agricultural, commercial, industrial, risk, kota, etc.). Filters can be very useful for refining suitability assessments. For example, it might be of special interest to know the most suitable places to build a new hospital but only in areas that have been recently affected by a natural disaster.

BOX #1: LAYER REQUIREMENTS

The datasets used in both Layers and Filters modules consist of shapefiles. It will depend on the type of data to be represented; however, the Urban Hotspots tool admits geometries such as points, polygons, and lines. There are no additional variables required to carry out the processes other than the location; however, it is recommended that layers refer to MMU's use polygons/multipolygons. In order to perform the assessment properly, it is necessary that the data matches in terms of territorial extent and use the same Coordinate Reference System to avoid any further discrepancy.

The Urban Hotspots tool will retrieve the layers and filters needed to perform its calculations

from the Geoportal database.

BOX #2: LAYER FILE FORMAT

The information format allowed for **uploading filters and layers** is shapefile **-shp-** in a **.ZIP format**.

If the information is available via Web Feature Services (WFS), it is possible to register the WFS on oskari and make the data available on Urban Hotspots or Urban Performance.

2.1.1.1 Spatial information: Layers (features & sources)

The data expected by the “**Layers**” module aims to define the area where the land suitability assessment will happen. Mainly these areas correspond to administrative boundaries, going from a local scale to a regional scale.

For this project, the data used as “**Layers**” consists of the administrative boundaries at a district scale delineated by the Geospatial Information Agency (Badan Informasi Geospasial-BIG) of the Republic of Indonesia. These boundaries have been elaborated between 2015 and 2019¹.

The boundaries for Balikpapan, Bandung, Banjarmasin, Denpasar, Semarang, and Surakarta were obtained in shapefile format and consist of polygons geometries.

It is important to mention that the boundaries can be modified, so the limits used in this project can differ from the last approved version, due to changes according to conditions/improvements in the field.

¹ Geospatial Information Agency of the Republic of Indonesia, 2015-2019. Map of Rupabumi Digital Indonesia. Bogor, West Java. Accessed from: <http://tanahair.indonesia.go.id/portal-web/>

On the other hand, the data on urban amenities and services are used to identify zones lacking coverage or to define suitable locations for future urban projects. This data consists of the location for the following amenities: clinics, cultural facilities (libraries, museums), elementary schools, high schools, hospitals, nurseries, markets, police stations, public spaces, sports facilities, worship, financial services, public services (government headquarters and offices), and public transportation.

The sources from which these datasets were retrieved depend not only on the theme but on the city as well.

Regarding the elementary and high schools, for Balikpapan, Bandung, and Banjarmasin, the locations were gathered mainly from the Rupa Bumi Indonesia databases. This information as well is generated by the Geospatial Information Agency (BIG) between 2015 to 2019.

The missing schools were compiled from the Open Street Maps Planet database dump 2019² by querying for schools and universities on the Education tree.

The locations for the elementary and high schools for Denpasar, Semarang, and Surakarta were obtained from the Open Street Maps Planet database dump 2019 by querying for schools and universities on the Education tree. This whole data was obtained in a shapefile format and consists of points geometries.

Similarly to the educational data, public transportation datasets were obtained from different sources. Bandung and Surakarta layers were generated based on the available information from the Moovit App, which consists of bus routes from 2019³, made up of lines geometries in a shapefile format.

For Balikpapan, Denpasar, and Semarang, data was gathered from two sources. One part came from the Open Street Maps Planet database dump 2019 by querying for bus stations on the Transportation tree, resulting in a shapefile format containing points geometries.

² OpenStreetMap Contributor. (2019) Planet dump Education Tree 2019 [shp format]. Retrieved from: <https://planet.openstreetmap.org>.

³ Moovit App, 2019. Transportation routes [JPEG format]. Retrieved from: <https://moovitapp.com/>

Additional information was obtained from the City Planning Labs-BAPPEDA database by requesting it through internal collaborators, who provided the bus routes for these cities in a shapefile format.

Finally, for the missing categories, the datasets were retrieved from the Open Street Maps Planet database dump 2019 by querying in the following trees: Emergency, Financial, Government, Public, and Sport.

2.1.1.2 Spatial information: Filters (features & sources)

Regarding the data expected by the “Filters” module, it represents specific areas within the city and it acts as a mask for extracting a specific zone for refining suitability assessments. For this project, these layers are related to risks, slums, natural zones, and heritage areas, and they were gathered from different sources.

The information related to risks was retrieved from the inaRISK initiative portal, which contains data that delineates the areas with disaster threats from different natural disasters such as droughts, earthquakes, tsunamis, landslides, land fires, volcanos. These datasets were developed by the Head of the National Disaster Management Agency (Badan Nasional Penanggulangan Bencana - BNPB) in 2018⁴.

For the slum data, it was gathered from different sources described below.

For Balikpapan and Denpasar, the data was obtained from the City Planning Labs - BAPPEDA database by requesting it through internal collaborators, who provided the slum areas in a shapefile with polygons geometries. Both datasets correspond to 2014.

⁴ Badan Nasional Penanggulangan Bencana-BNPB (2018), Indonesia Disaster Risk Index (Indeks Risiko Bencana Indonesia) [Raster file]. Retrieved from: <http://service1.inarisk.bnpb.go.id:6080/arcgis/rest/services/inaRISK>

The information for Bandung and Banjarmasin was generated based on documentation that delimitates the slum areas defined by the KOTAKU Program (Kota Tanpa Kumuh), owned by the Ministry of Public Works and Housing (Kementerian Pekerjaan Umum dan Perumahan Rakyat). There was a shapefile made up of polygons geometries representing the slum zones for Banjarmasin generated on 2016⁵ and on 2017⁶ for Bandung. While the information for Semarang corresponds to 2014⁷ and to 2015⁸ for Surakarta.

It is important to mention that even though the development of documentation and works for these 4 cities were coordinated by the KOTAKU Program, each city was in charge of generating its own Action Plan in order to attend the specific concerns for each of them through the local Ministries of Public Works and Housing.

The heritage layers that represent only cultural heritage areas, were retrieved from the Spatial Plan (Rencana Tata Ruang Wilayah-RTRW) from each city. Bandung, Banjarmasin, and Balikpapan had not previously digitized these areas, so they were generated from its maps in JPEG format, resulting in a shapefile made up of polygon geometries. The dates of this information correspond to 2012, 2012 and 2013 correspondingly.

While for Denpasar, Semarang, and Surakarta, the heritage areas boundaries are formally defined and available in a georeferenced format (.shp) conformed by polygons, being 2011 the year in which they were generated.

⁵ Kementerian Pekerjaan Umum dan Perumahan Rakyat (2016). RK 3 Priority slum handling activities in the Pekauman Kelayan Area, Banjarmasin City [Presentation/Slides], Retrieved from: <https://slideplayer.info/slide/17035073/>

⁶ F. K. Maula et al 2019, IOP Conf. Ser.: Earth Environ., Sci. 385 012035

⁷ Kementerian Pekerjaan Umum dan Perumahan Rakyat (2014). Slum Improvement Action Plan. Neighborhood Upgrading and Shelter Project Phase 2. Kota Semarang [Presentation/Slides], Retrieved from: <https://www.slideshare.net/bogesi/slum-improvement-action-plan-siap-nusp2-kota-semarang>

⁸ Kementerian Pekerjaan Umum dan Perumahan Rakyat (2015). Residential Area Plan: Urban Slums. Regional agreement & priority handling. Kota Surakarta Kota Semarang [Presentation/Slides], Retrieved from: <https://www.slideshare.net/bogesi/penentuan-kawasan-kumuh-kota-surakarta-tahun-2015>

2.1.2 Normalization parameters

Making calculations with more than one layer or filter might be a difficult task since the data can be in different units. As a result, the Urban Hotspots tool standardizes layers and filters with different units and translates them into one single index. In order to make the layers comparable, the **Normalization Method** included in the tool, standardizes all information layers into one single index. Normalization includes two different methods — **benchmark or standardize**—. The **benchmark** method, see Equation (1), consists of choosing the most desired (**Highest Value**) and least desirable values (**Lowest Value**) a specific variable can have (commonly national or international standards). Once done, the rest of the values are reclassified according to how close they are to the chosen limits.

$$index = 100 * \frac{x - min}{max - min} \quad \text{Equation (1)}$$

Where, *index* is the suitability index, *x* is the value to be normalized and *min* and *max* are Lowest Value and Highest Value, as defined by the user.

The **standardize** method is similar to the observe method, but calculations are based on the values' standard deviation, as opposed to the values themselves.

It is also possible to assign **Weight** for specific layers. Weights are commonly based on the most important cities' priorities or on stakeholder's concerns. To perform the weighing of layers the tool computes the Urban Hotspots index as a weighted mean, see Equation (2). This implies that before calculating all the layers' mean, their individual Urban Hotspots index will be multiplied by its assigned weight. Layers with a higher weight will have more participation in the calculation of the Urban Hotspots index.

$$index = \frac{\sum_{i=1}^n xi * wi}{\sum_{i=1}^n wi}$$

Equation (2)

Where, *index* is the overall score, *xi* is the normalized score, *wi* is the assigned weight to the layer, and *n* is the total amount of selected layers.

Once all the variables have been standardized, the tool can perform a correction for such cases where smaller layer-values represent a higher suitability index. For example, to find a location that optimizes commuting time, the user could select a layer like *proximity to education* facilities and *density of employment*. For the first case, shorter distances represent shorter trips to school or a higher index, i.e. smaller numbers are better. For the second case, higher density of employment opportunities represents shorter trips to work or a higher index. Following this example, the user would select **Smaller better**, see Equation (3), for *proximity to education* and would deactivate it for *density of employment*.

$$index = 100 - i \quad \text{Equation (3)}$$

Where *index* is the adjusted Urban Hotspots index and *i* is the non-adjusted index.

In summary, the Smaller better option has two possible states: false and true. When false, the furthest areas from the analysis points are the best (blue) while the closest ones are the worst (red). Inversely, areas closest to the analysis points will be the best (blue), while the furthest ones will be the worst (red). Index values will always be the same. The only thing that changes is the way in which the analysis points are associated with some color according to the user's analysis interests.

Users can adjust the way results are displayed. A user can reverse the scale for their analysis so that the lowest value is displayed in blue and the highest value is displayed in red. A user can also select a “free” scale (which adapts to max and min index values) instead of the fixed one (with values that go from 0 to 100). For more information about these functionalities, please refer to the user manual for Urban Hotspots.

2.1.3 Ways to show information and output formats

Once an evaluation has been run, the results will be visualized on the map by sending them to Oskari as a GeoJSON object, with formatting and styling provided by Oskari's options and temporarily set as an Oskari layer; if we leave the Geoportal or reload, the layer won't be saved. Currently, this GeoJSON object cannot be downloaded.

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We acknowledge the invaluable support of the World Bank's Trust Fund for Statistical Capacity Building (TFSCB) in the making of this project. The latest version of Urban Hotspots was developed at City Planning Labs and is maintained by CAPSUS, UPTech and a community of developers. Urban Hotspots is open source and its source code can be found at GitHub. Visit our webpage to learn more about the project <http://suitability.in>