Address level food environments 2004 - 2018

Spatial coverage	The Netherlands
Temporal range	2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018
Data source input data:	Locatus / GECCO
Data format input data:	Point location table (Excel)
Data format output data:	Raster (*.tif) / Point location table (*.csv)
Data storage output data:	..\Geodata\Data_aanvragen\Gabi\Results
Table files (output):	j04.csv, j06.csv, j08.csv, j10.csv, j12.csv
GIS files (output):	j04_KD1LF500.tif, j04_KD2LF1000.tif, j04_KD3LF1500.tif, j04_KD4FF500.tif, j04_KD5FF1000.tif, j04_KD6FF1500.tif, j04_ KD7RS500.tif, j04_ KD8RS1000.tif, j04_PD9FD1500.tif, j04_KD10RS500.tif, j04_KD11RS1000.tif, j04_KD12RS1500.tif, j04_KD13SM500.tif, j04_KD14SM1000.tif, j04_KD15SM1500.tif, j04_ PC16FD500.tif, j04_ PC17FD1000.tif, j04_ PC18FD1500.tif, j04_ KD19OF_LF500.tif, j04_ KD20OF_LF1000.tif, j04_ KD21OF_LF1500.tif, j04_ KD22OF_FF500.tif, j04_ KD23OF_FF1000.tif, j04_ KD24OF_FF1500.tif, j04_ KD25OF_RS500.tif, j04_ KD26OF_RS1000.tif, j04_ KD27OF_RS1500.tif, j04_ KD28OF_SM500.tif, j04_ KD29OF_SM1000.tif, j04_ KD30OF_SM1500.tif, j04_ KD31OF_CS500.tif, j04_ KD32OF_CS1000.tif, j04_ KD33OF_CS1500.tif, j04_ KD34OF_FD500.tif, j04_ KD35OF_FD1000.tif, j04_ KD36OF_FD1500.tif, j04_ KD37HS500.tif, j04_ KD38HS1000.tif, j04_ KD39HS1500.tif Idem j06_*, j08_*, j10_*, j12_*, j14_*, j16_*, j18_*

Data description

This dataset was developed to study changes in the neighborhood availability of different types of food retailers in the Dutch foodscape for every two years from 2004 to 2018 and find possible associations with the incidence of cardiovascular disease (see Pinho et al., in progress). To this end the dataset presents the kernel density of different groups of aggregated of food retailers (local food shops, fast food restaurants, food delivery, restaurants, supermarkets, small grocery/convenience stores and all other food retailers) and the kernel density of their total health score according to the calculated food environment healthiness index (FEHI) for each retailer. The FEHI Index has values between -5 and + 5

according to the FEHI score list developed by Maartje Poelman (Timmermans et al., 2018). The input data on food retailers concerns the Locatus point data set of the food environment for the chosen years between 2004 and 2012 (see Metadatasheet - Locatus food environment 2016 for a general description of this dataset).

The reason for calculating grid based distance weighted kernel densities is that the food environment has to be determined on address level, so for each possible residential location in the Netherlands. By calculating grid based kernel densities distance based information on the food environment is gathered around each possible location (each 25x25 meters gridcel in a regular spaced raster) in a circle with a radius of respectively 500, 1000 and 1500 meters. For each gridcell the distance weighted retailers per aggregation class (counts) are summed up and subsequently averaged over the corresponding circular neighborhoods. A value of zero means there are no food retailers within the applied buffer zone. Details about the specific distance function in the kernel density analysis function from the applied ESRI ArcGIS software can be found in the appendix of this metadatasheet.

For the aggregation class 'food delivery' point densities were calculated instead of kernel densities. This means only the number of food delivery points within a neighborhood is relevant and not the distance to each individual food delivery point as is the case with the other variables.
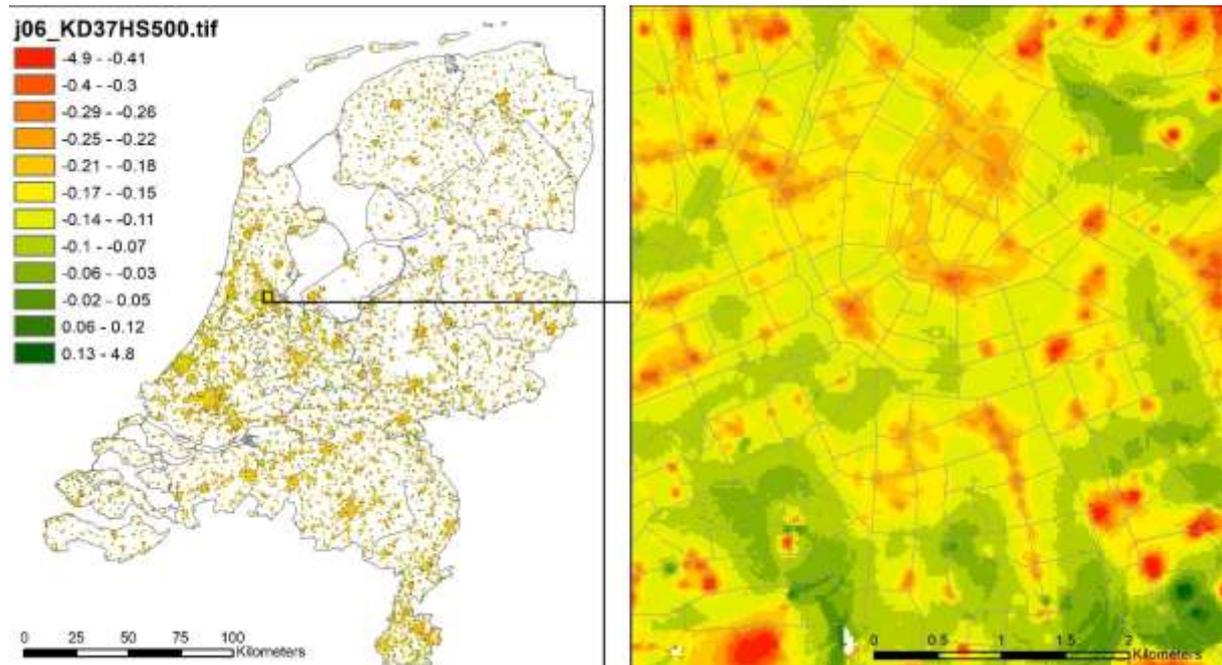
Different from the other variables is also the kernel density variable of the health scores. In this case the variable is not limited to an aggregated group of retailers but considers all retailers with a health score within a 500, 1000 or 1500 meter radius neighborhood. In this case the presence of and the distance to each retailer is also weighted by the health score of each retailer in the kernel density calculation. For this distance weighted kernel density calculation we used a custom made kernel distance function, see the appendix for explanation. The calculated health score densities range from -5 to +5. NoData, implying not within range of any food retailer, is represented by the value -2147480.

After calculating all grid variables, grid values were extracted to the corresponding locations of the circa nine million address locations in the Netherlands and exported as variable fields to a table format with address locations and XY coordinates.
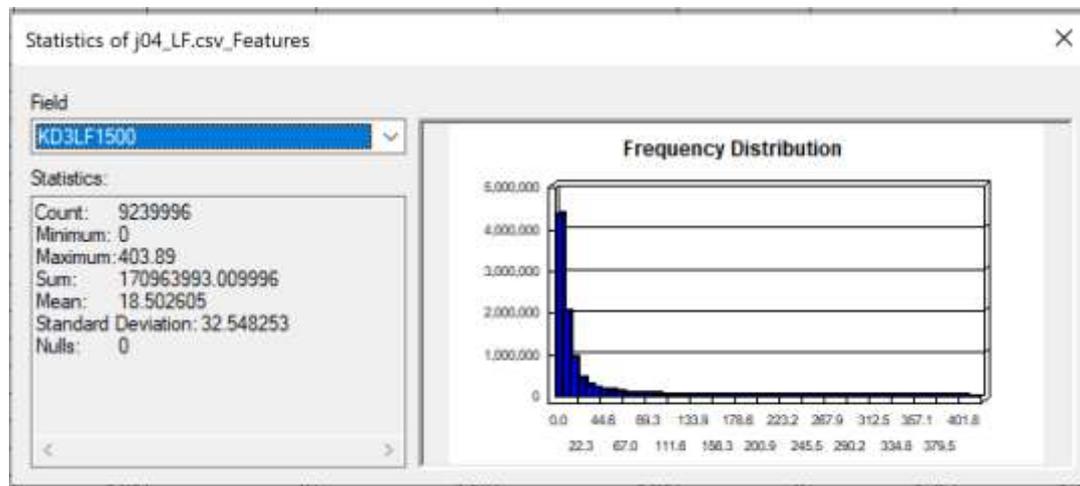
The figures underneath show respectively a map example of the kernel density of health scores in 2006 with a 500 meter radius and the table statistics for the kernel density values distribution of Local Food shops in 2004 with a 1500 m radius.

Map example kernel density health scores 2006 – 500 m radius (Quantile classification)

C:\Work\VUmc-GECCO\Geodata\Data_aanvragen\Gabi\Map overview health scores.mxd

Example frequency distribution (point statistics) kernel density values Local Food shops 2004 with 1500 m radius

Variables

Table 1: overview of variables in dataset

Variable name	Description
Postcode	Postal 6 code
Huisnummer	House number

Huisletter	House letter
Toevoeging	House number / letter addition
nummeraanduiding_id	Number indication id
X	X coordinates Dutch coord. system (Rijksdriehoek-stelsel)
Y	Y coordinates Dutch coord. system (Rijksdriehoek-stelsel)
KD1LF500	1: Kernel density Local Food shops 500 meter radius
KD2LF1000	2: Kernel density Local Food shops 1000 meter radius
KD3LF1500	3: Kernel density Local Food shops 1500 meter radius
KD4FF500	4: Kernel density Fast Food restaurants 500 meter radius
KD5FF1000	5: Kernel density Fast Food restaurants 1000 meter radius
KD6FF1500	6: Kernel density Fast Food restaurants 1500 meter radius
KD7RS500	7: Kernel density ReStaurants 500 meter radius
KD8RS1000	8: Kernel density ReStaurants 1000 meter radius
KD9RS1500	9: Kernel density ReStaurants 1500 meter radius
KD10SM500	10: Kernel density SuperMarkets 500 meter radius
KD11SM1000	11: Kernel density SuperMarkets 1000 meter radius
KD12SM1500	12: Kernel density SuperMarkets 1500 meter radius
KD13CS500	13: Kernel density Convenient Stores 500 meter radius
KD14CS1000	14: Kernel density Convenient Stores 1000 meter radius
KD15CS1500	15: Kernel density Convenient Stores 1500 meter radius
PC16FD500	16: Point count Food Delivery 500 meter radius
PC17FD1000	17: Point count Food Delivery 1000 meter radius
PC18FD1500	18: Point count Food Delivery 1500 meter radius
KD19OF_LF500	19: Kernel density Other Food retailers (no LF) 500 m
KD20OF_LF1000	20: Kernel density Other Food retailers (no LF) 1000 m
KD21OF_LF1500	21: Kernel density Other Food retailers (no LF) 1500 m
KD22OF_FF500	22: Kernel density Other Food retailers (no FF) 500 m
KD23OF_FF1000	23: Kernel density Other Food retailers (no FF) 500 m
KD24OF_FF1500	24: Kernel density Other Food retailers (no FF) 500 m
KD25OF_RS500	25: Kernel density Other Food retailers (no RS) 500 m
KD26OF_RS1000	26: Kernel density Other Food retailers (no RS) 500 m
KD27OF_RS1500	27: Kernel density Other Food retailers (no RS) 500 m
KD28OF_SM500	28: Kernel density Other Food retailers (no SM) 500 m
KD29OF_SM1000	29: Kernel density Other Food retailers (no SM) 500 m

KD30OF_SM1500	30: Kernel density Other Food retailers (no SM) 500 m
KD31OF_CS500	31: Kernel density Other Food retailers (no CS) 500 m
KD32OF_CS1000	32: Kernel density Other Food retailers (no CS) 500 m
KD33OF_CS1500	33: Kernel density Other Food retailers (no CS) 500 m
KD34OF_FD500	34: Kernel density Other Food retailers (no FD) 500 m
KD35OF_FD1000	35: Kernel density Other Food retailers (no FD) 500 m
KD36OF_FD1500	36: Kernel density Other Food retailers (no FD) 500 m
KD37HS500	37: Kernel density Healthiness Score 500 meter radius
KD38HS1000	38: Kernel density Healthiness Score 1000 meter radius
KD39HS1500	39: Kernel density Healthiness Score 1500 meter radius

Data processing:

See appendix

Source

Locatus is market leader in the field of independently sourced retail information in Europe. It gathers its own data on all shops and consumer-oriented service companies and makes this information accessible for its clients through an online database. Locatus started in the year 2000 with the registration of all stores in the Netherlands and is expanding its databases now to other European countries.

Locatus data is commercial data and needs therefore to be purchased if to be used for commercial purposes. For research purposes other special arrangements can be made with Locatus. Both Amsterdam UMC / Department E&B and GGHDC in Utrecht have specific contracts for the use of Locatus data.

URL: https://locatus.com

Data quality

See information provided by locatus

Contact information

Source data Locatus

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Terms and conditions

See contract Amsterdam UMC – Locatus and contract GGHDC - Locatus

List of references

Timmermans, J., Dijkstra, C., Kamphuis, C., Huitink, M., Van der Zee, E., & Poelman, M. (2018). 'Obesogenic'School Food Environments? An Urban Case Study in The Netherlands. *International journal of environmental research and public health*, *15*(4), 619.

APPENDIX: Data processing

Add Locatus XY data to ArcGIS

Step 1

Use Arc Catalog to choose the Locatus *.xlsx sheet format (not the *.xls Excel 97-2003 sheet format because that will reduce your number of records to a maximum of 65535 records). Click the + sign to select the first sheet and add that to the table of contents in ArcGIS.

Step 2

Right click the table layer in the TOC and select Display XY data. Make sure to the right fields are selected for the X Field (XCOORD) and the Y Field (YCOORD). Next click Edit to indicate the appropriate coordinate system belonging to the listed coordinates, which is in this case WGS 1984 in the geographic coordinate system (GCS_WGS_1984). Now click OK.

Step 3

Choose Project from ArcToolbox / Projections and transformation, choose the new event layer as input dataset, give a name to the new project output dataset and select the desired output coordinate system which is in this case RD_New (this is the Dutch coordinate system Rijksdriehoekstelsel).

Aggregation of food retailers

Different food retailer categories were defined for this project according to the definition of exposure measures. In table 1 the original Locatus retail branches are given in the left column and the aggregated categories and their abbreviation used in the file names are given in the right column.

Table 1. *Food retailer categories as defined by Locatus were aggregated for the definition of exposure measures.*

Locatus original category	Aggregated analytical category
Groente/Fruit (Greengrocery) Poelier (Butchery - chicken/birds) Bakker (Bakery) Vis (Fish stores) Slagerij (Butchery)	Local food shops (LF)
Fastfood Grillroom/Shoarma	Fast food restaurants (FF)
Bezorgen (food delivery)	Food delivery (FD)
Hotel-restaurant Café-restaurant Restaurant	Restaurants (RS)
Supermarkt	Supermarket (SM)
Minisuper	Small grocery/convenience stores (CS)
Vlaaien (Pastry shop) Toko (Oriental food shop) Buitenl OV (Foreigner shop) Chocola (chocolate shop)	All other food retailers + the food retailers not included in the main exposure measure, as described t Table 2.

Delicatessen (Specialty store)	(OF_LF; OF_FF; OF_FD; OF_RS; OF_SM; OF_CS)
Kaas (Cheese store)	
Noten (Nut store)	
Reform (Organic food stores)	
Zoetwaren (Confectionery store)	
Levensmiddelen overige (Food stores – other)	
Koffiehuis (Turkish or Moroccan cafeteria)	
IJssalon (Ice cream shop)	
Lunchroom (Restaurant (all day food))	
Pannenkoeken (Pancake store / Crêperie)	

In the regression modelling for the associated research project different model runs will be carried out with different exposure measures. This means that for each exposure measure that is chosen (one of the aggregated groups of food retailers) a different 'all other food retailer category' is formed, that contains all food retailers that are not part of the modeled exposure measure. For instance, in the model where Local food shops will be the exposure measure, the 'all food retailer category' will include all other food retailers apart from the retailers that constitute Local Food shops. Table 2 gives an overview of the food retailers that are part of the 'all other food retailer category' for each separate measure.

Table 2. *Description of the food retailers composing the different 'All other food retailers' category*

OF_LF	OF_FF	OF_RS	OF_SM	OF_CS	OF_FD
Fastfood	Groente/Fruit	Groente/Fruit	Groente/Fruit	Groente/Fruit	Groente/Fruit
Grillroom/Shoarma	Poelier	Poelier	Poelier	Poelier	Poelier
Bezorgen	Bakker	Bakker	Bakker	Bakker	Bakker
Hotel-restaurant	Vis	Vis	Vis	Vis	Vis
Café-restaurant	Slagerij	Slagerij	Slagerij	Slagerij	Slagerij
Restaurant	Bezorgen	Fastfood	Fastfood	Fastfood	Fastfood
Supermarkt	Hotel-restaurant	Grillroom/Shoarma	Grillroom/Shoarma	Grillroom/Shoarma	Grillroom/Shoarma
Minisuper	Café-restaurant	Bezorgen	Bezorgen	Bezorgen	Hotel-restaurant
Vlaaien	Restaurant	Supermarkt	Hotel-restaurant	Hotel-restaurant	Café-restaurant
Toko	Supermarkt	Minisuper	Café-restaurant	Café-restaurant	Restaurant
Buitenl OV	Minisuper	Vlaaien	Restaurant	Restaurant	Supermarkt
Chocola	Vlaaien	Toko	Minisuper	Supermarkt	Minisuper
Delicatessen	Toko	Buitenl OV	Vlaaien	Vlaaien	Vlaaien
Kaas	Buitenl OV	Chocola	Toko	Toko	Toko
Noten	Chocola	Delicatessen	Buitenl OV	Buitenl OV	Buitenl OV
Reform	Delicatessen	Kaas	Chocola	Chocola	Chocola
Zoetwaren	Kaas	Noten	Delicatessen	Delicatessen	Delicatessen
Levensmiddeln OV	Noten	Reform	Kaas	Kaas	Kaas
Koffiehuis	Reform	Zoetwaren	Noten	Noten	Noten
IJssalon	Zoetwaren	Levensmiddeln OV	Reform	Reform	Reform
Lunchroom	Levensmiddeln OV	Koffiehuis	Zoetwaren	Zoetwaren	Zoetwaren
Pannenkoeken	Koffiehuis	IJssalon	Levensmiddeln OV	Levensmiddeln OV	Levensmiddeln OV
	IJssalon	Lunchroom	Koffiehuis	Koffiehuis	Koffiehuis
	Lunchroom	Pannenkoeken	IJssalon	IJssalon	IJssalon
	Pannenkoeken		Lunchroom	Lunchroom	Lunchroom
			Pannenkoeken	Pannenkoeken	Pannenkoeken

The selection queries for the different aggregations of food retailers are given in the Python script 'Pro Process_Locatus_data_Gabi_01mar22.py'.

An example query for the aggregation of the local food shops category in 2004 for application in ArcMap is given here below.

****

Add text field named 'Aggreg_cat' to attribute table.

SELECT FROM LOCATUS_2004_rd WHERE:

"BRANCHE" = '11.010.012-Groente/Fr' OR "BRANCHE" = '11.010.399-Poelier' OR "BRANCHE" = '11.010.111-Bakker' OR "BRANCHE" = '11.010.588-Vis' OR "BRANCHE" = '11.010.471-Slagerij'

10072 out of 71087 selected

Next, use Field Calculator to give the value 'Local food shops' to the selected records and subsequently calculate kernel density.

The complete operations for all years including the kernel and point density calculations were executed via ArcPy based Python scripts, see for details the python script 'Process_Locatus_data_Gabi_8may20.py'.

Calculation of healthiness scores

All relevant food retailer categories are given healthiness scores according to the following table (table 3) and are based on the food environment healthiness index (FEHI) as defined by Maartje Poelman in Timmermans et al. (2018) with values between -5 and + 5.

Table 3. Healthiness score according to each food retailer category.

Food outlet	Scores
Groente- en fruitboer	4.8
Visboer	2.8
Notenbar	2.2
Supermarkt (bv. AH, Jumbo, Dirk v/d Broek, EkoPlaza)	1.8
Toko (Traditioneel Oosterse supermarkt/winkel)	1.5
Koffie of theewinkel (e.g. Simon Leevelt, Kaldi, Nespresso)	1.3
Bakker	1.2
Reformwinkel (e.g. natuurwinkel, reformhuis, de groene winkel, vitaminewinkel)	1.0
Poelier (verkoop van gevogelte (bv. kip)	0.6
Delicatessewinkel (e.g. hapjes / verse kant-en-klaar maaltijden en producten)	0.2
Slagerij (verkoop allerlei vlees: rund, varken, gevogelte, etc.)	-0.4
Hotel-restaurant	-0.9
Restaurant	-0.9
Kaaswinkel	-1.3
Lunchroom/ koffiebar (Bijvoorbeeld: Bagels & Beans, Délifrance, Panache, Subway, Bakkerswinkel, Doppio, Starbucks, Coffee company)	-1.5
Café-restaurant	-1.9
Café	-2.3
Pannenkoeken-restaurant	-3.2
Afhalen/bezorgen (bijvoorbeeld. Chinees, Thais, pizza/pasta, Taco's)	-3.7

IJssalon	-3.9
Chocoladewinkel (e.g. bonbonnière, Leonidas)	-4.3
Vlaaienwinkel	-4.4
Tabac en lectuurwinkel (bijvoorbeeld: Primera, Kiosk)	-4.5
Benzinestation	-4.5
Slijterij	-4.6
Zoetwaren (Bijvoorbeeld: Jamin)	-4.7
Grillroom/Shoarma	-4.8
Snackbar / fastfood outlets	-4.9
Minisupermarkets*, includes:	
Turkse/ Marokkaanse supermarket	2.0
AH to go / de 'buurtsuper'	0.3
Avondwinkel	-2.1
Remaining stores	0.1
Overige shops, includes:	
Cupcake/muffin winkel	4.5
Landwinkel/boerderijwinkel	1.5

Excluded branches:		No scores assigned
11.010.120-Buitenl Ov	59.210.127-Koffiehuis	
11.010.912-Ziekenh Wink	59.210.133-Coffeeshop	
11.020.024-Apotheek	59.210.150-Discotheek	
11.020.156-Drogist	59.210.234-Hotel	
11.020.393-Parfumerie	59.210.465-Partycentrum	
11.020.950-Pers Verz Ov	59.210.950-Horeca Ov	

The selection of the different categories and assignment of associated healthiness scores was first carried out in ArcMap using a query based on the attribute name and subsequently automated in a Python script for all years and categories. See Python script 'Calculate_Healthiness_scores _Locatus_data_Gabi_4May20.py'.

Specific queries and selections had to be carried out for the Locatus category (branche) 'minisupers' and 'Levensmiddelen OV'.

The Locatus category minisuper has been divided in 4 new categories and given each a different score:
(1) Turkish supermarkets, including 'versmarkten' and retailers with 'fruit and groenten' receive a score of **2.0**
(2) Avondwinkel (e.g., avondshops, nightshops, avondverkoop) receive a score of **-2.1**
(3) On-the-way shops, including AH to go, buurtsuper, wizzle and STIPT, receive a score of **0.3**
(4) The remaining food retailers receive an average score of **0.1**

The selection of Turkish supermarkets is performed manually by checking the list of names in the Locatus Excel database. A new field named 'SUBBRANCHE' was added to the Locatus point file to indicate the records that fall inside the class Turkish supermarkets. In that case the field record is assigned the value 'Turkish-ao-freshmarkets'[1].

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[1] Procedure: join the Locatus layer for the specific year to the table with manually selected Turkish supermarkets, including 'versmarkten' and retailers with 'fruit and groenten' using the 'Key' field (concatenation of postcode and housenumber and housenumberaddition) and assign the value 'Turkish-ao-freshmarkets' to the SUBBRANCHE field. Note that for the years from 2014 onwards I have linked these tables using the Locatus field 'unitid' instead of a key field with postcode/housenumber/house addition. The Locatus field 'unitid' refers to an unique number linked to the building in which the retailer is established regardless of the retailer branche. This means when the retailer in a building changes the unitid stays the same.

The Locatus category 'Levensmid Ov' has been divided in 3 new categories, which have been given different scores:

(1) Cupcake/muffin winkel receive a score of **-4.5**

(2) Landwinkel/boerderijwinkel*, including fruitshops, 'hoeve', 'molen', receive a score of **1.5**

(3) The remaining food retailers receive an average score of -**1.5**

In the above selections boerderij/landwinkels are excluded when they include the words 'zuivel', 'kaas' or 'ijs' in their names as these concern usually retail of food products from dairies (melkveehouderijen) without the full range of healthy / fresh products like vegetables that we expect to come from the selected boerderij/landwinkels.

Also the selection of the three different categories in 'Levensmid Ov' is performed in ArcGIS / Python using a query based on the attribute name. See Python script 'Calculate_Healthiness_scores _Locatus_data_2004to2018.py'

Calculation of variables

For each variable either a kernel density[2] or a point count is calculated.

Kernel point densities take into account both the distance and the values of points within a search neighborhood. For our list of variables point values are only considered for variables 37, 38 and 39 in which the health scores are the considered point values. In the case of variables 1 to 15 and 19 to 36 point values are not considered (population field = None) and all points are weighted equally.

In the case of point counts (variables 16, 17 and 18) the number of occurring points is counted within each analysed neighborhood.

Variables #1 to #18 are derived according to the aggregated categories as defined in Table 1. Variables #19 to #36 are derived according to Table 2. Variables #37 to #39 are derived according to the 'healthiness scores': weights to each food retailer are assigned according to Table 3. All these variables are created for the years 2004, 2006, 2008, 2010, 2012. In a later stage we will decide whether or not we will need these variables also for the years 2005, 2007, 2009 and 2011.

1. Kernel density for Local food shops (LF) within 500 metres buffer
2. Kernel density for Local food shops (LF) within 1000 metres buffer
3. Kernel density for Local food shops with (LF) in 1500 metres buffer
4. Kernel density for Fast food restaurants (FF) within 500 metres buffer
5. Kernel density for Fast food restaurants (FF) within 1000 metres buffer
6. Kernel density for Fast food restaurants (FF) within 1500 metres buffer
7. Kernel density for Restaurants (RS) within 500 metres buffer
8. Kernel density for Restaurants (RS) within 1000 metres buffer
9. Kernel density for Restaurants (RS) within 1500 metres buffer
10. Kernel density for Supermarket (SM) within 500 metres buffer
11. Kernel density for Supermarket (SM) within 1000 metres buffer
12. Kernel density for Supermarket (SM) within 1500 metres buffer

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[2] The kernel function in ArcGIS is based on the quartic kernel function described in Silverman (1986, p. 76, equation 4.5) where the volume under the surface equals the Population field value for the point. The surface value is highest at the location of the point and diminishes with increasing distance from the point, reaching zero at the Search radius distance from the point.

13. Kernel density for Convenience stores (CS) within 500 metres buffer
14. Kernel density for Convenience stores (CS) within 1000 metres buffer
15. Kernel density for Convenience stores (CS) within 1500 metres buffer
16. **Count** of food delivery (FD) places within 500 metres buffer[3]
17. **Count** of food delivery (FD) places within 1000 metres buffer
18. **Count** of food delivery (FD) places within 1500 metres buffer
19. Kernel density for 'All other food retailers – LF' (OF_LF) within 500 metres buffer
20. Kernel density for 'All other food retailers – LF' (OF_LF) within 1000 metres buffer
21. Kernel density for 'All other food retailers – LF' (OF_LF) within 1500 metres buffer
22. Kernel density for 'All other food retailers – FF' (OF_FF) within 500 metres buffer
23. Kernel density for 'All other food retailers – FF' (OF_FF) within 1000 metres buffer
24. Kernel density for 'All other food retailers – FF' (OF_FF) within 1500 metres buffer
25. Kernel density for 'All other food retailers – RS' (OF_RS) within 500 metres buffer
26. Kernel density for 'All other food retailers – RS' (OF_RS) within 1000 metres buffer
27. Kernel density for 'All other food retailers – RS' (OF_RS) within 1500 metres buffer
28. Kernel density for 'All other food retailers – SM' (OF_SM) within 500 metres buffer
29. Kernel density for 'All other food retailers – SM' (OF_SM) within 1000 metres buffer
30. Kernel density for 'All other food retailers – SM' (OF_SM) within 1500 metres buffer
31. Kernel density for 'All other food retailers – CS' within (OF_CS) 500 metres buffer
32. Kernel density for 'All other food retailers – CS' within (OF_CS) 1000 metres buffer
33. Kernel density for 'All other food retailers – CS' within (OF_CS) 1500 metres buffer
34. Kernel density for 'All other food retailers – FD' (OF_FD) within 500 metres buffer
35. Kernel density for 'All other food retailers – FD' (OF_FD) within 1000 metres buffer
36. Kernel density for 'All other food retailers – FD' (OF_FD) within 1500 metres buffer
37. Kernel density for Healthiness score (HS) within 500 metres buffer
38. Kernel density for Healthiness score (HS) within 1000 metres buffer
39. Kernel density for Healthiness score (HS) within 1500 metres buffer

Kernel densities are calculated using the kernel density tool within the ArcMap Spatial Analist tool group. The following settings were applied:

<u>Kernel density</u>

Population field: none
Output cell size: 25 meter
Search radius: 500, 1000 or 1500 meter
Area map units: square kilometres
Output format: Geotif (*.tif), 32 bit, floating point

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[3] Availability of food delivery places is now represented by the density of these places within different radii. In a later stage we might derive their availability differently when we can determine a mean delivery radius for neighbourhoods with different SES and urbanization status. Then a service area could be determined for each food delivery places based on this determined delivery range. The number of service areas overlapping the individual home address will then be assigned to that individual.

The count of food delivery places is calculated by applying the 'point statistics analysis', part of the spatial analyst neighborhood tools. The following settings were applied:

Point statistics (count)

Field: Count
Output cell size: 25 meter
Neighborhood: Circle
Neighborhood radius: 500, 1000 or 1500 meter
Neighborhood units: map
Statistics type: SUM
Output format: Geotif (*.tif), 16 bit, signed integer

The resulting fle is copied to a 32 bit file as this is necessary for the extraction to address coordinates using the GeoDMS script that was made for this project by Object vision.

File name conventions are the following:

File name example:	**j06_KD3LF1500.tif**
Year of analysis:	**j06**_KD3LF1500.tif
Analysis type:	j06_**KD**3LF1500.tif (**K**ernel **D**ensity / **P**oint **C**ount)
Variable number:	j06_KD**3**LF1500.tif
Variable abbreviation:	j06_KD3**LF**1500.tif (**L**ocal **F**ood)
Search radius in meters:	j06_KD3LF**1500**.tif
File extension type:	j06_KD3LF1500**.tif**

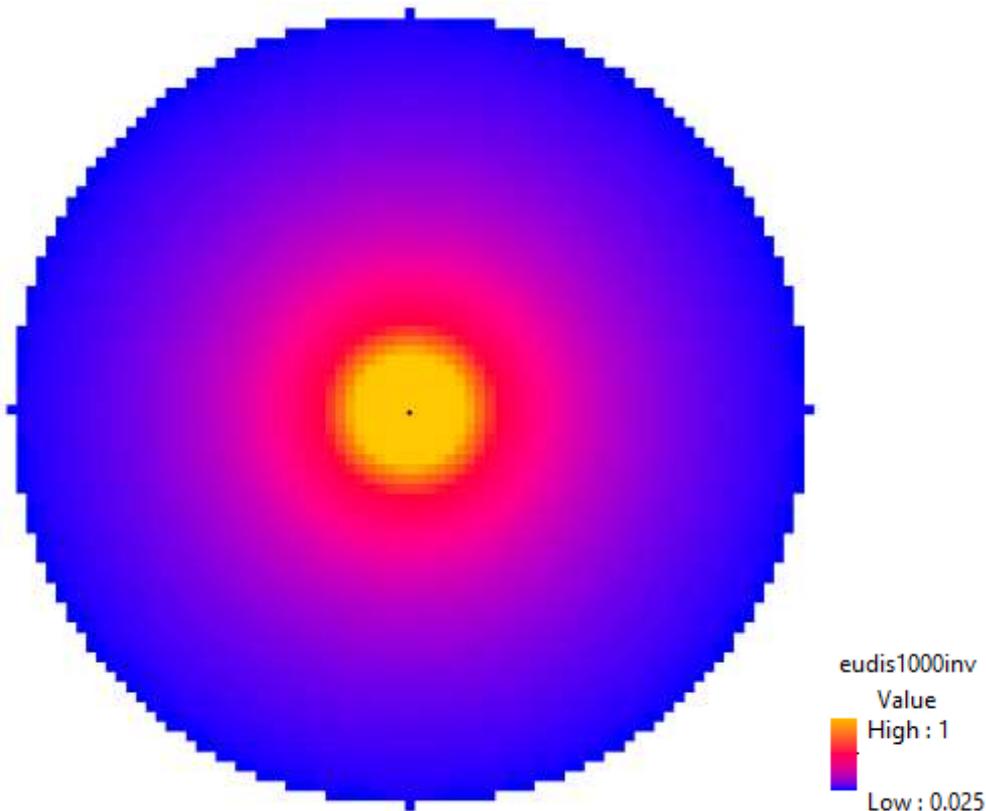Create custom kernels to create kernel densities for health scores

Because the ArcGIS kernel density tool does not give the desired result when used for health scores ranging from negative to positive values, we have produced custom kernel files and subsequently used those in a neighbourhood analysis to produce kernel densities.

The kernel files are constructed as follows (see ArcGIS flow chart and explanation below):

1) Create vector point file with a single point (Name: disfun2.shp)

2) Calculate Euclidean Distance (Spatial Analyst / Distance Tools / Euclidian Distance) with a maximum distance of 1000 meters and an output cell size of 25 meters. Resulting raster: 'eucdis1000'

3) Convert all raster values into floating point values. Resulting raster: 'eucdis1000f'

4) Use the Map Algebra function to calculate the inverse values and multiply with the cell size of 25 meters ((1 / eudis1000f) * 25) to get decreasing values from 1 in the centre to near 0 at the borders. Resulting raster: 'eucdis1000inv' (see figure below)

eudis1000inv
Value
High : 1

Low : 0.025

5) Transform the raster into a ascii text-file named

6) Edit the asci textfile as follows:

Adapt header of textfile:

```
ncols        82
nrows        82
xllcorner    -1025
yllcorner    -1025
cellsize     25
NODATA_value -9999
 -9999  -9999  -9999  -9999
 -9999  -9999  -9999  -9999
 -9999  -9999  -9999  -9999
```
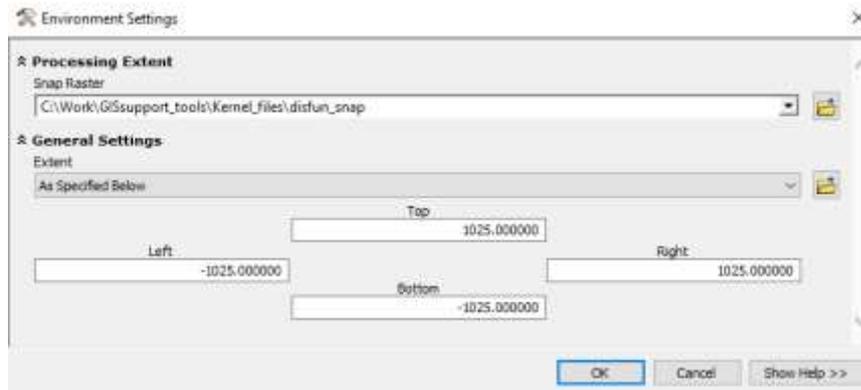
```
   82       82
 -9999  -9999  -9999  -9999
 -9999  -9999  -9999  -9999
 -9999  -9999  -9999  -9999
```

- Replace central NoData value (-9999) with value 1. Find this value by executing a search with search value '1 -9999 1'.
- Replace all -9999 values with value 0.
- The resulting kernel text-file should look now like this (see example below for 500 meter kernel), the blue circle indicates the central values in the kernel.

Note that for the creation of the kernel file in ArcGIS the following Environment settings were applied in ArcGIS modelbuilder:
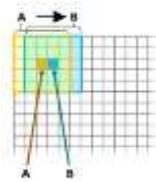

The resulting kernel files for 500, 1000 and 1500 meters are now ready to calculate the kernel health score densities using the ArcGIS focal statistics (neighbourhood analysis) function in our Python script, as in the following script example:

arcpy.gp.**FocalStatistics_sa**(tempPath + "**Locatus_2014_HS_RD.tif**", outputPath + "2014\\j14_KD37HS500.tif", "Weight C:\Work\GISsupport_tools\Kernel_files**kernel_weight_500m.txt**", "**MEAN**", "DATA")
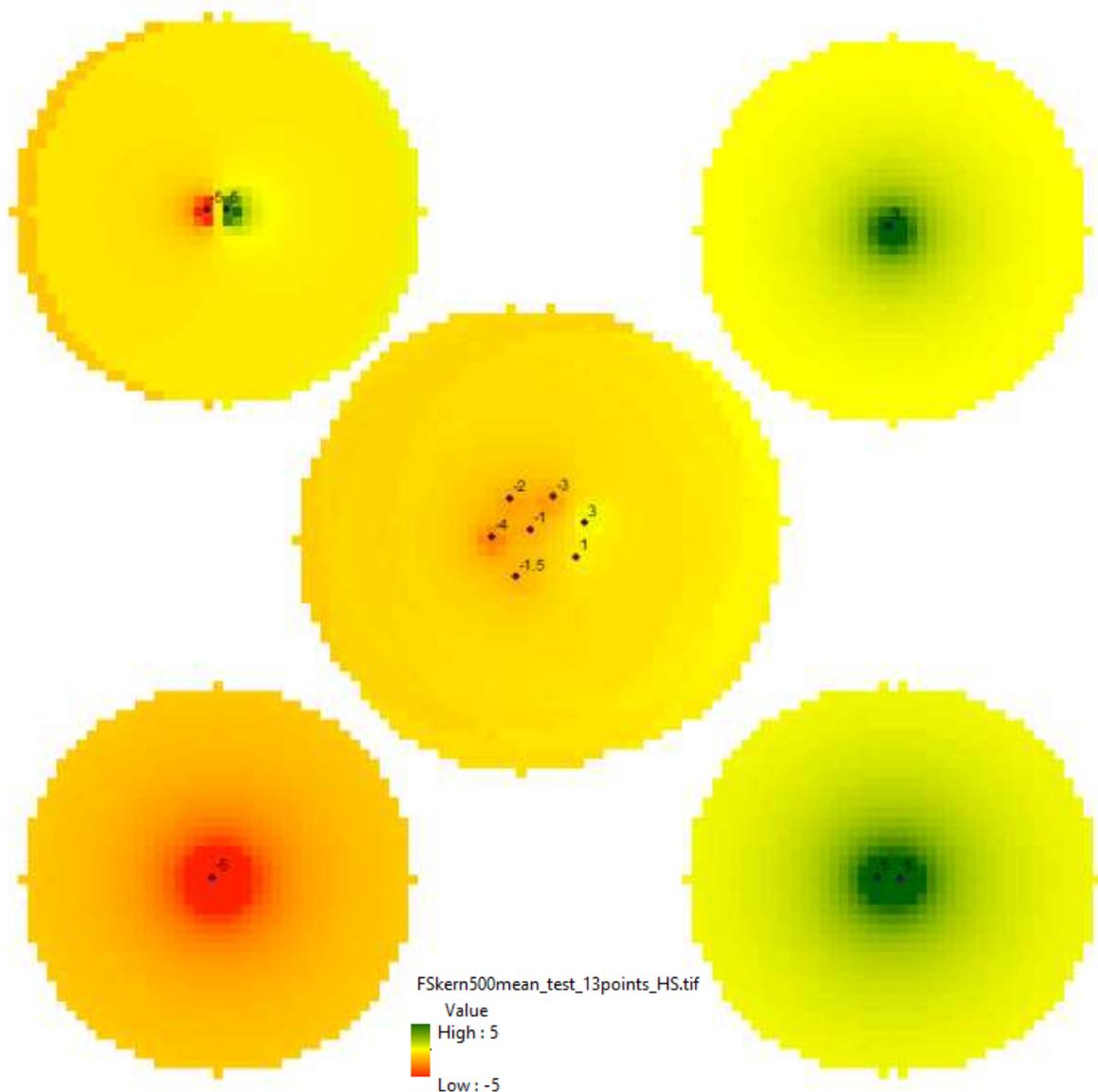
In this analysis the neighborhood function looks for each cell in the analysis grid at occurring values in the neighborhood and applies the distance decay function ($y = 1/x * 25$) using the distance weights in the kernel density text file. This takes care that the values in the analysis grid around the central cell are multiplied with the distance decay weights in the kernel density text file until the maximum kernel distance is reached. For example, in case of a maximum kernel distance of 500 meters and an analysis cell at a distance of 25 meters distance to a certain food retailer, the health score for this

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food retailer is assigned the maximum weight (1/25 *25 = 1 times the health score). But in case the food retailer is at 250 meters distance it is assigned a weight of 1/250 *25 (= 0.1 times the health score) and at the edge of the 500 meter kernel (1/ 500 * 25 = 0.05 times the health score). Finally, in every kernel neighborhood all distance weighted values within a neighborhood are summed and averaged, so you get a score between -5 and +5.

The same neighborhood analysis is repeated for each cell in the grid as this is the general concept of all neighborhood analyses, also called 'moving window analysis'. This means the analysis window (or kernel) is applied on all individual cells in a rasterfile, one for one. Starting in e.g. the left above cell and then moving to the next cell (from A to B in the figure below), etc. until the analysis ends with an analysis window in the cell in the right below corner of the grid.

To illustrate this process this distance weighted neighborhood analysis is applied on an imaginary set of 13 different food retailers with different health scores indicated. The result is visible in the figure below and shows clearly the effect of applying the distance weighted neighborhood function.

FSkern500mean_test_13points_HS.tif
Value
High : 5
Low : -5

Extraction grid kernel density / point count values to address coordinates

The calculated grid kernel density and point count values are extracted to the 9 million address coordinates in The Netherlands by using a 'GeoDMS' application that was specifically designed for this purpose by Object Vision. For each extraction process the associated GeoDMS scripts need to be adapted. Each year is extracted separately and takes place within a couple of minutes. Output is a table in *.csv format of approximately 2.2 GB in filesize.

Please note that in sparsely populated areas there are locations without any food retailers within short distance. This means that the calculated kernel densities for several variables with small radii (especially 500 meter and smaller) can be zero. In general, the smaller the bufferradii used for calculating kernel densities, the higher the number of raster cells with zero values you can find in such areas. In the case of kernel healthscores (which we calculate differently with custom kernel files) areas without retailers have no healthscores and become NoData in the resulting tables (coded in the output tables by the GeoDMS software with value -2147480000000).