Case study
Applying Value Maps - Berg en Dal, The Netherlands

The area of tension between Safety Region Gelderland-Zuid and Developer KlokGroep

René Vaartjes

8 November 2018

UNIGIS Amsterdam

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Introduction

The municipality of Berg en Dal has asked UNIGIS, together with two stakeholders, the Safety Region Gelderland-Zuid and developer KlokGroep, to explore which area is best suited for multi-purpose area development (buildings that have a residential or business function).

Both stakeholders have a different kind of interest. The municipality asked UNIGIS to investigate their concerns

The Safety Region is responsible for fire service care, medical assistance and preparation and coordination in the field of disaster relief and crisis management. It aims to prevent and respond to disasters and crises as effectively as possible (Veiligheidsregio Gelderland -Zuid, 2018).

Developer KlokGroep realises new homes in the municipality of Berg en Dal. Market research shows that there is demand for houses in the price range between € 250,000 and € 400,000, which must be within walking distance of a primary school and close to the main road (provincial road) for commuter traffic (TNO, 2017).

The municipality has pre-sorted three different building areas:

Area 1) A piece of land of 4.6 hectares west of the village of Millingen aan den Rijn on the Heerbaan.
Area 2) A piece of land of 4.6 hectares south of the village of Berg en Dal. The area is intersected by the Zevenheuvelenweg.
Area 3) A piece of land of 4.6 hectares northwest of Groesbeek along the N842

Method

In the topographical map of the Netherlands, first, the municipal boundaries have been loaded (Esri, 2018). The municipal boundaries of Berg en Dal were selected and the other municipal boundaries were removed. Subsequently, a grid was laid over the Berg en Dal area with areas of 100 x 100 metres. Based on the indicators provided, the various values were drawn for both the Safety Region and the developer.

Prior to a workshop in which the best location is jointly determined, the criteria of interest to a stakeholder were determined one-to-one with the UNIGIS advisor.

Study area

Berg en Dal lies west of Nijmegen in the province of Gelderland, The Netherlands, contains 12 villages and covers 93,3 km^2. The Municipality of Berg en Dal has 35.574 inhabitants (Statistisch Zakboek Gelderland, 2016). The proposed development areas are coloured yellow.

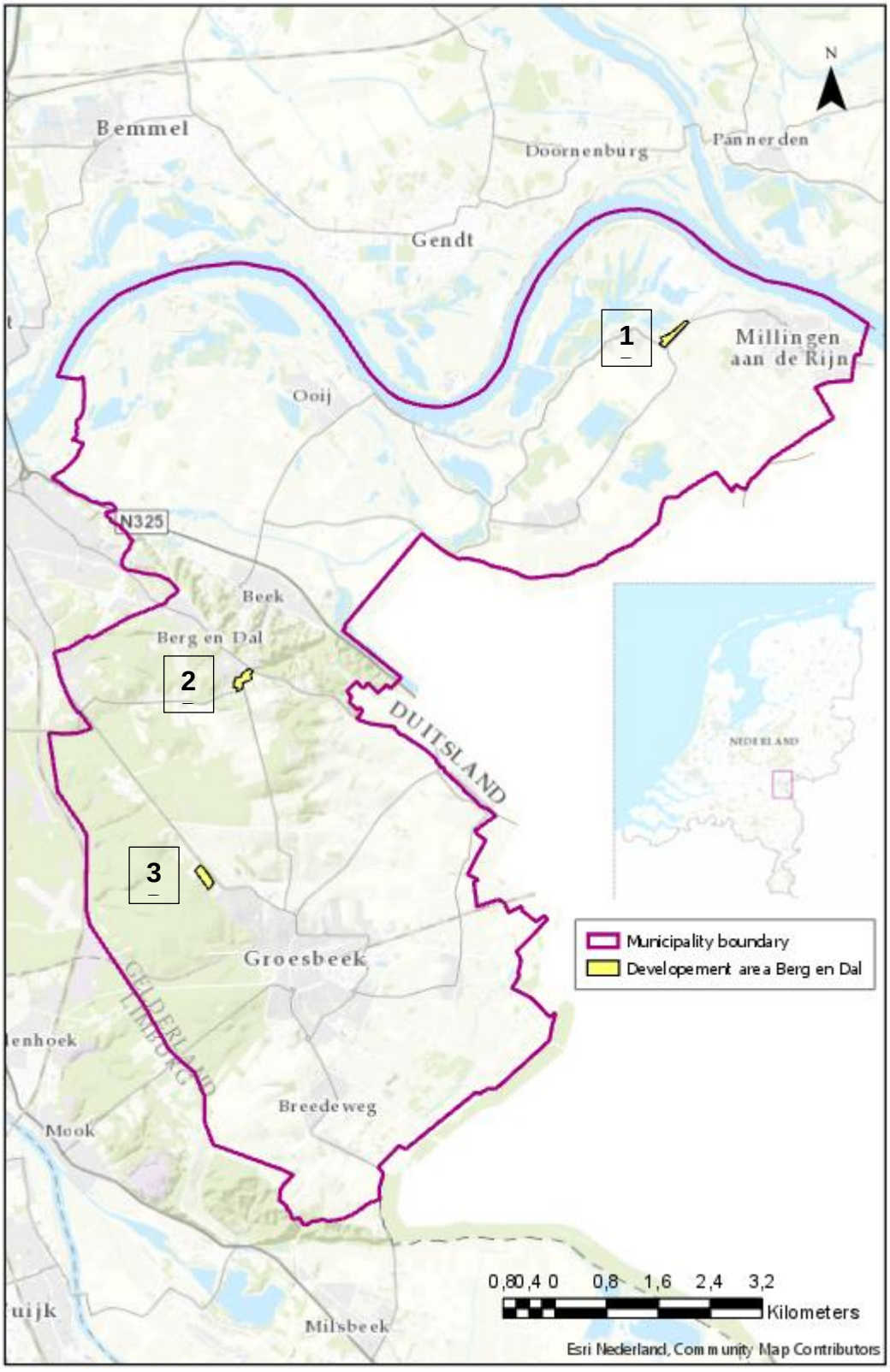

Figure 1: Study area.

Value functions

Criteria Safety Region Gelderland-Zuid
The following principles are essential for the Safety Region. The lower the value, the less an area is suitable for housing.

Attribute	Value	Impact
Areas where a combination of the probability of flooding with an increased emission of particulate matter is possible.	-5	Greater chance of a calamity or damage due to the presence of two negative indicators.
Areas where a combination of the probability of a fire hazard with an increased emission of particulate matter is possible.	-4	Greater chance of a calamity or damage due to the presence of two negative indicators.
Areas along roads with increased emissions of particulate matter (PM2.5) (Milieudefensie, 2018)	-3	Three levels of particulate matter are used: High (> 10 ug/m3), medium (7.5 to 10 ug/m3) and low (5 to 7.5 ug/m3). Various health studies (WHO 2013a) have shown that long-term stays near busy roads lead to health risks, especially for the so-called highly sensitive groups (children, the elderly and the sick). (Dijkema, M., et al. 2018)
Areas with high and medium risk of flooding. (Risicokaart.nl, 2018)	-2	Floods occur at least once every 100 years (risicokaart.nl, 2018), can cause significant economic damage and thousands of victims cannot be excluded. (Knoop, J. and Ligtvoet, W., 2014)
Area with risk of fire hazard. (Risicokaart.nl, 2018)	-1	The risk of natural fires can increase very rapidly during dry periods in dry types of nature. (Gemeente Groesbeek, 2013).
Areas without any form of risk. (Risicokaart.nl, 2018)	0	No impact. These areas are preferred in order to be eligible for urban development.

Table 1: Criteria and impact level urban development - Safety Region Gelderland-Zuid

Fire hazard
The average driving time of the fire brigade in Gelderland-Zuid is 8.1 minutes. During a warm period, such as in May and June 2017, more fires may occur in the nature reserves or outside areas. Determining the location will then become more difficult, which may result in a more extended call out, turn out and driving times. (CBS, 2018). A network analysis using the Network Analyst Service Area tool in Arcgis Pro shows that driving times can be as long as 12 minutes (figure 2). Challands (2018) has investigated that as the turn out time increases, the damage also increases exponentially (figure 3).

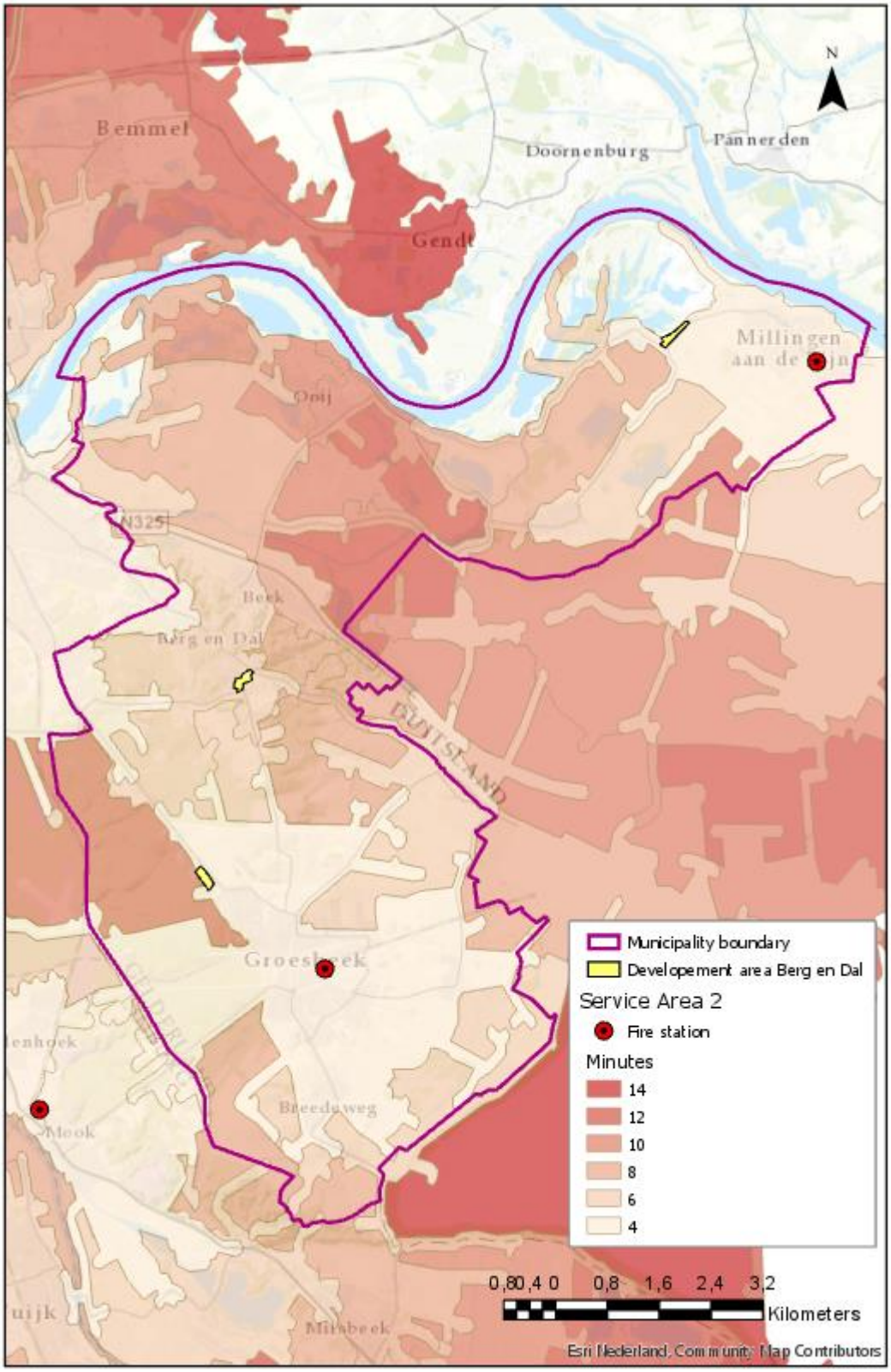

Figure 2: Driving time in minutes from fire station to fire hazard

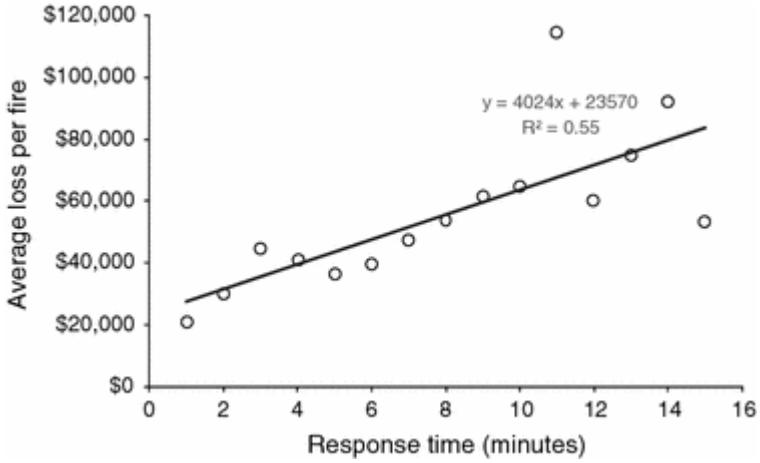

Figure 3: The nominal average value ($NZ) of damage to the structure per fire for each minute of fire service response [n=26384] (Challands, 2010)

Flood Hazard

Kok (2014) uses a formula to calculate the flood damage:

$$S = \sum_{i=1}^{n} \alpha_i n_i S_i$$

ai = damage factor category i
ni = number of units in category i
Si = maximum damage per unity in category i

The following parameters influence the damage factor:

- flood depth (metre)
- flow velocity (metre per second)
- critical flow rate (metre per second)
- rate of climb (metres per hour) (significant for determining the number of casualties)
- material factor (home building material: stones or concrete)
- protective factor
- presence of storm (waves)

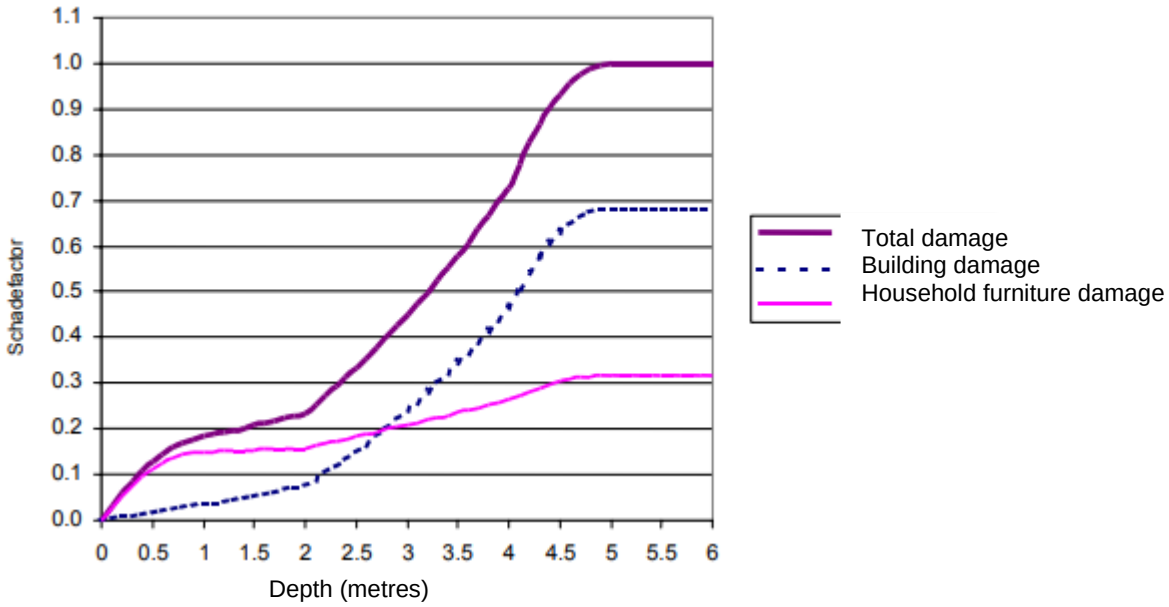

Figure 4: Damage factor single-family houses and farms (no storm or current) (Kok, M., 2004)

Based only on a maximum water depth of 0.8 metres (risicokaart.nl, 2018), the damage factor for total damage is approximately 0.175. Resulting in an average damage amount of € 38.150 per dwelling.

Air pollution

The Municipal Health Service advises not to build new sensitive destinations within 300 metres of a motorway or directly on a busy provincial or inner city road. (Weerdt, R. van de, Zuurbier, M., 2017)

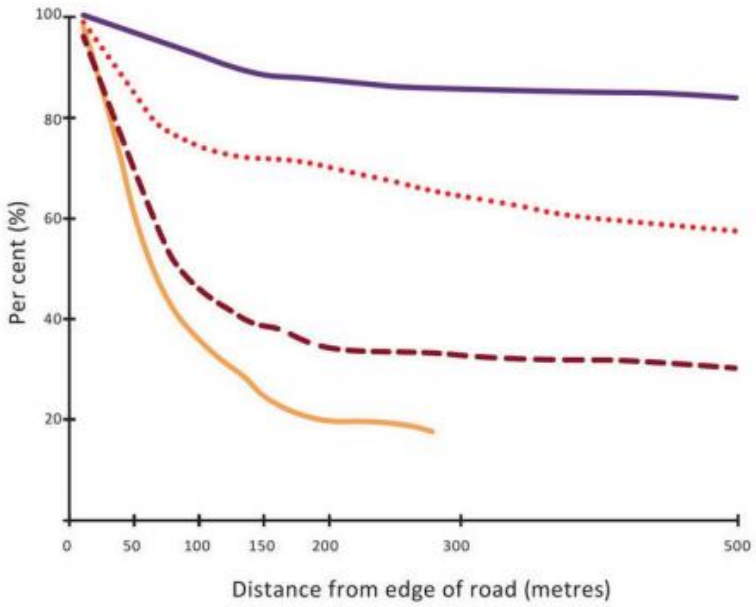

Figure 5: Decrease in concentrations of particulate matter with distance to the road (Karner et al. 2010)

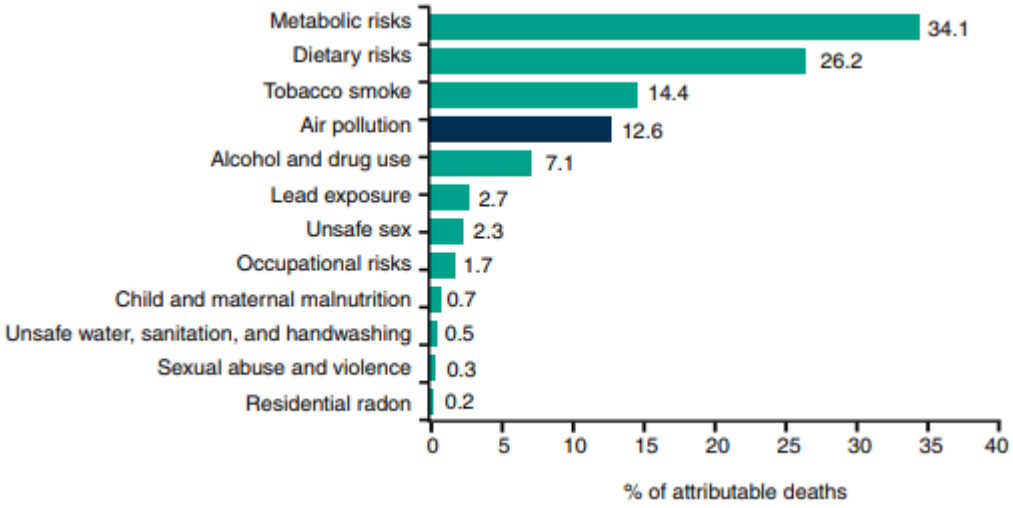

Figure 6: Percentage of Attributable Deaths by Risk Factor: Upper-Middle-Income Countries, 2013 (GBD, 2013)

Criteria developer KlokGroep
For the KlokGroep the following attributes are essential. The higher the value, the more an area is suitable for urban development.

	Attribute	Value	Impact
A	Areas that are not of value to the developer to develop	0	Null
B	Areas where the average value of a dwelling is between € 250.000 and € 400,000 (CBS, 2016)	1	Clustering of similar dwellings or occupants. The living environment also determines the price of a dwelling (Visser, P., Dam, F. van and Noorman, N., 2006). Houses with a sales price higher than the average Dutch Real Estate Appraisal Act (WOZ) value in Berg en Dal, € 218.000,- (CBS, 2018) A higher disposable income has a positive influence on the spending behaviour which can benefit the local business community.
C	Areas where the maximum distance to a provincial road is 2 kilometre. (Rijkswaterstaat, 2018)	2	Good accessibility, shorter travel time to work or leisure use
D	Areas within 15 minutes walking distance of a primary school. (Gemeente Berg en Dal, 2018)	3	Attractive to young families.
E	Areas containing representing a combination of criteria B and C	4	
F	Areas containing representing a combination of criteria B and D	5	
G	Areas containing representing a combination of criteria C and D	6	
H	Areas containing representing a combination of criteria B, C and D	7	Areas are the most attractive to develop.

Table 2: Criteria and impact level urban development – developer

Accessibility
Van Wee (1994) states that the choice of a home and the location of the dwelling is based, among other things, on the distances and travel times to relevant locations (work, social contacts and facilities). Gerritsen (2017) confirms this statement: "In this study, commuting time is the relatively most important factor on which residential consumers choose their location. Also, a shorter distance from the construction site to a through road leads to lower construction costs.

Distance to primary school
A walking distance of up to 15 minutes to a primary school encourages to walk or cycle.

1	More traffic experience, faster development of observation and estimation skills	Traffic
2	Better cycling skills	
3	Better fitness	Health
4	Better concentration, better learning	
5	Better eating and sleeping	
6	Less overweight	
7	Lower risk of asthma	
8	More interaction with neighbour's children	Social aspects
9	Discovering the world on foot or by bike	
10	Solving disputes better	

Table 3: Ten benefits of walking and cycling for children (Dashboard Schoolmobiliteit, 2012)

Value Maps

The stakeholder values for the three areas mentioned in the introduction are listed in the graphs below and visualised in the value maps.

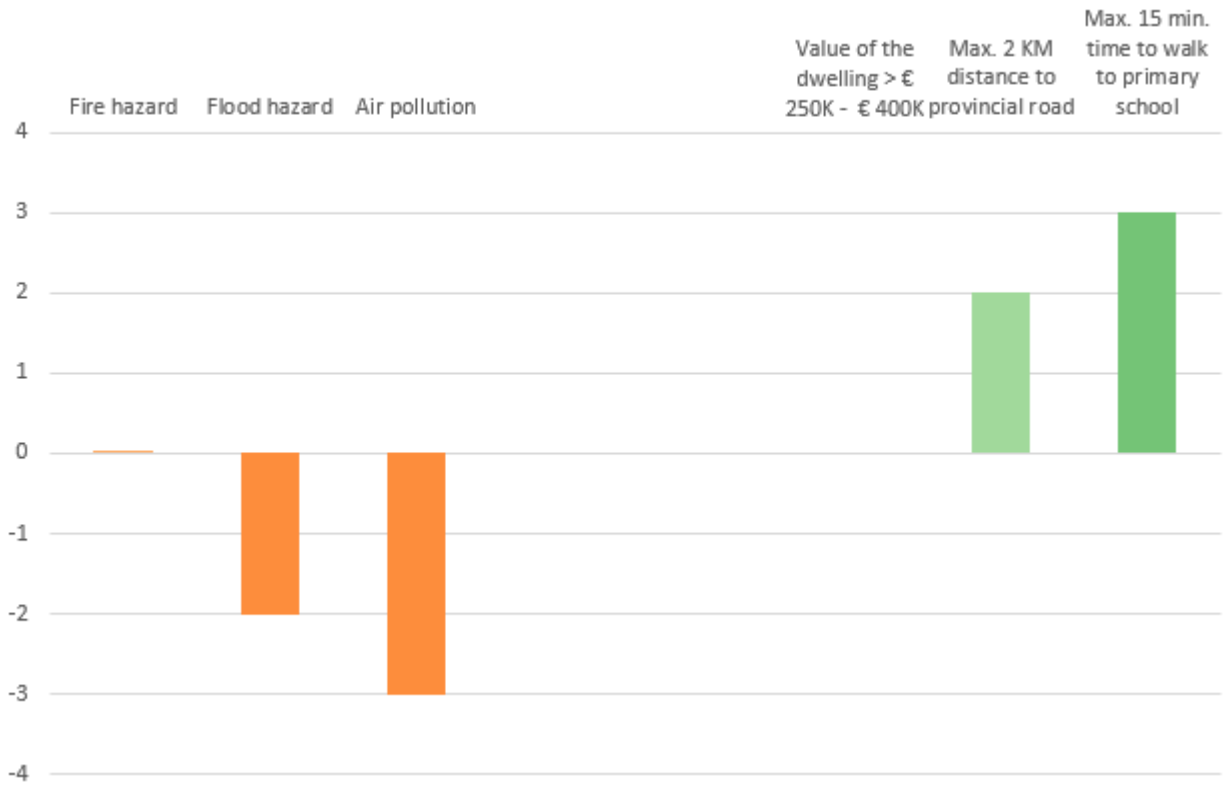

Figure 7: Area 1

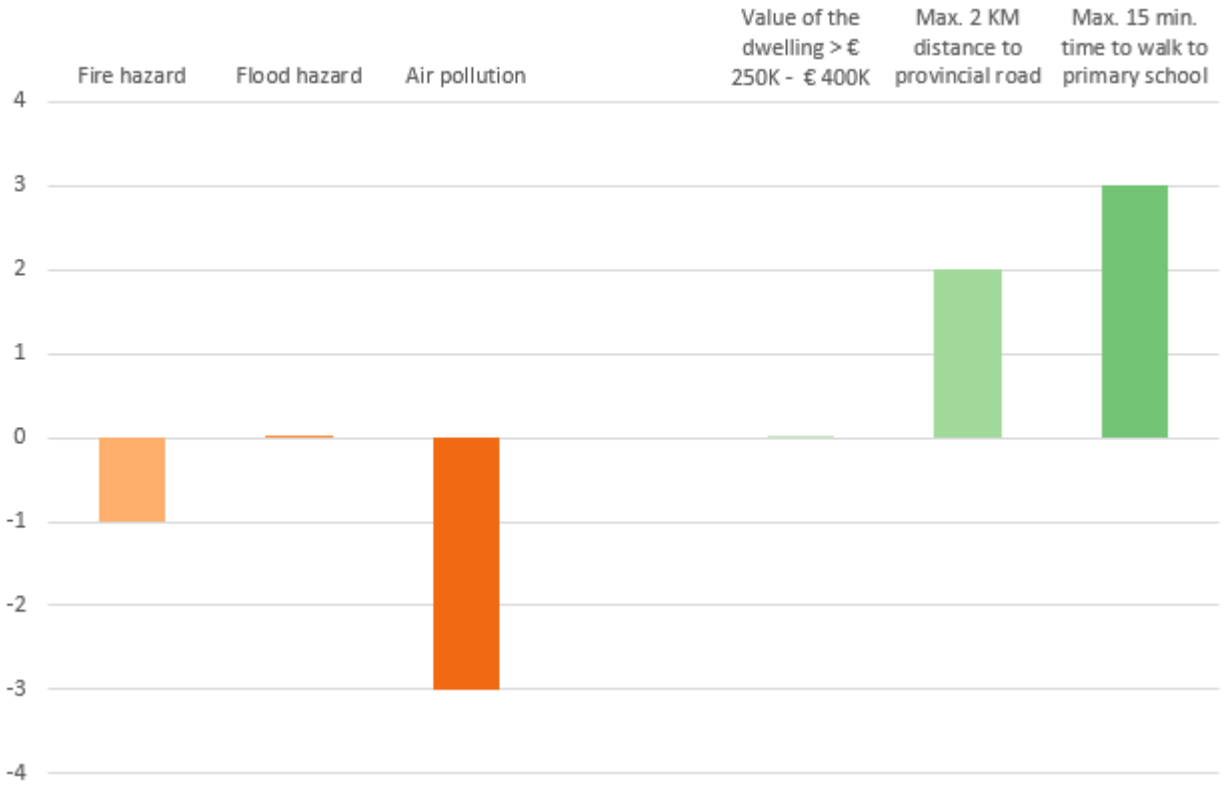

Figure 8: Area 2

Figure 9: Area 3

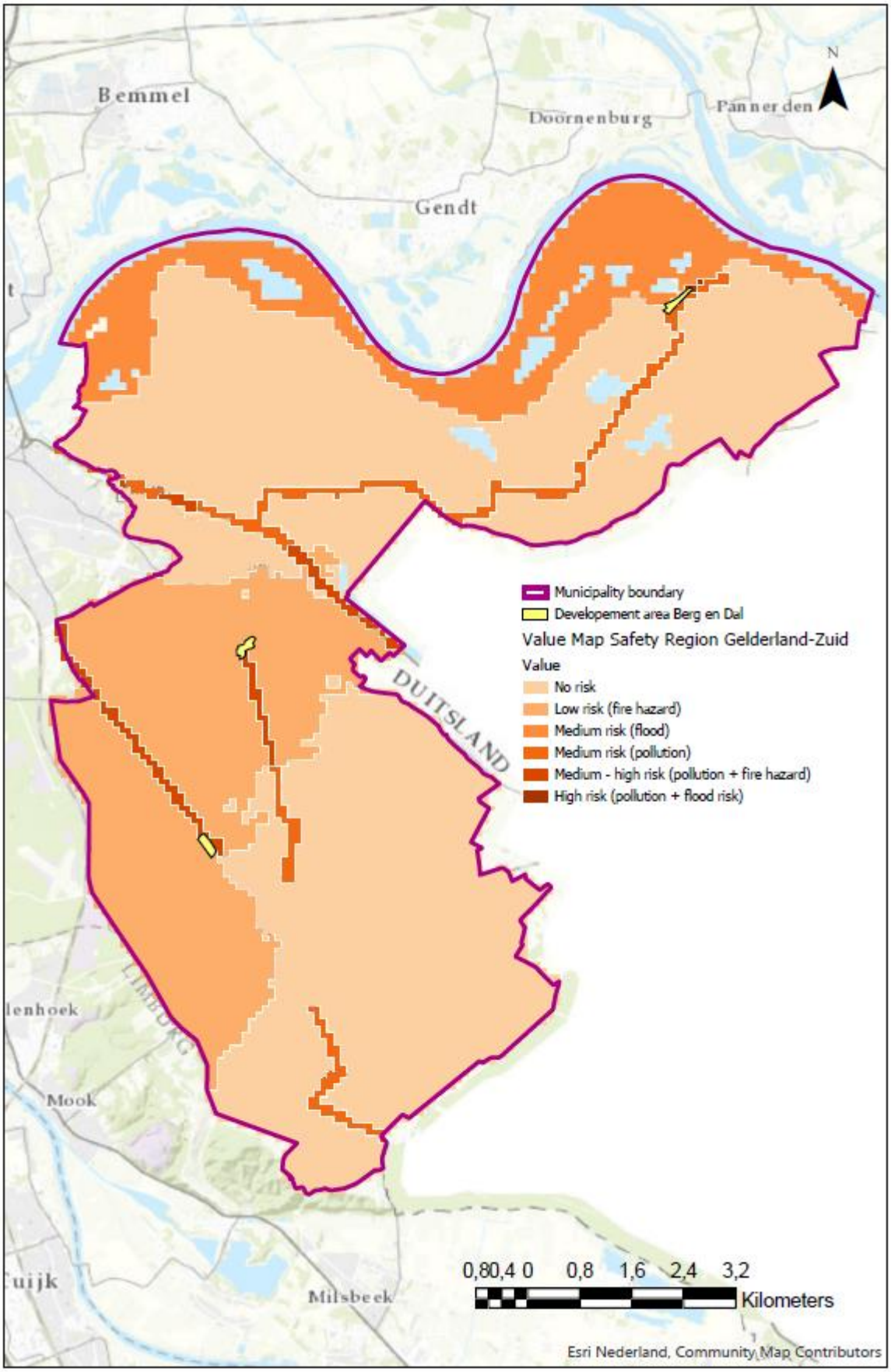

Figure 10: Value Map Safety Region Gelderland-Zuid (click for an interactive map) (https://geoplaza.maps.arcgis.com/apps/StorytellingSwipe/index.html?appid=47a5d)

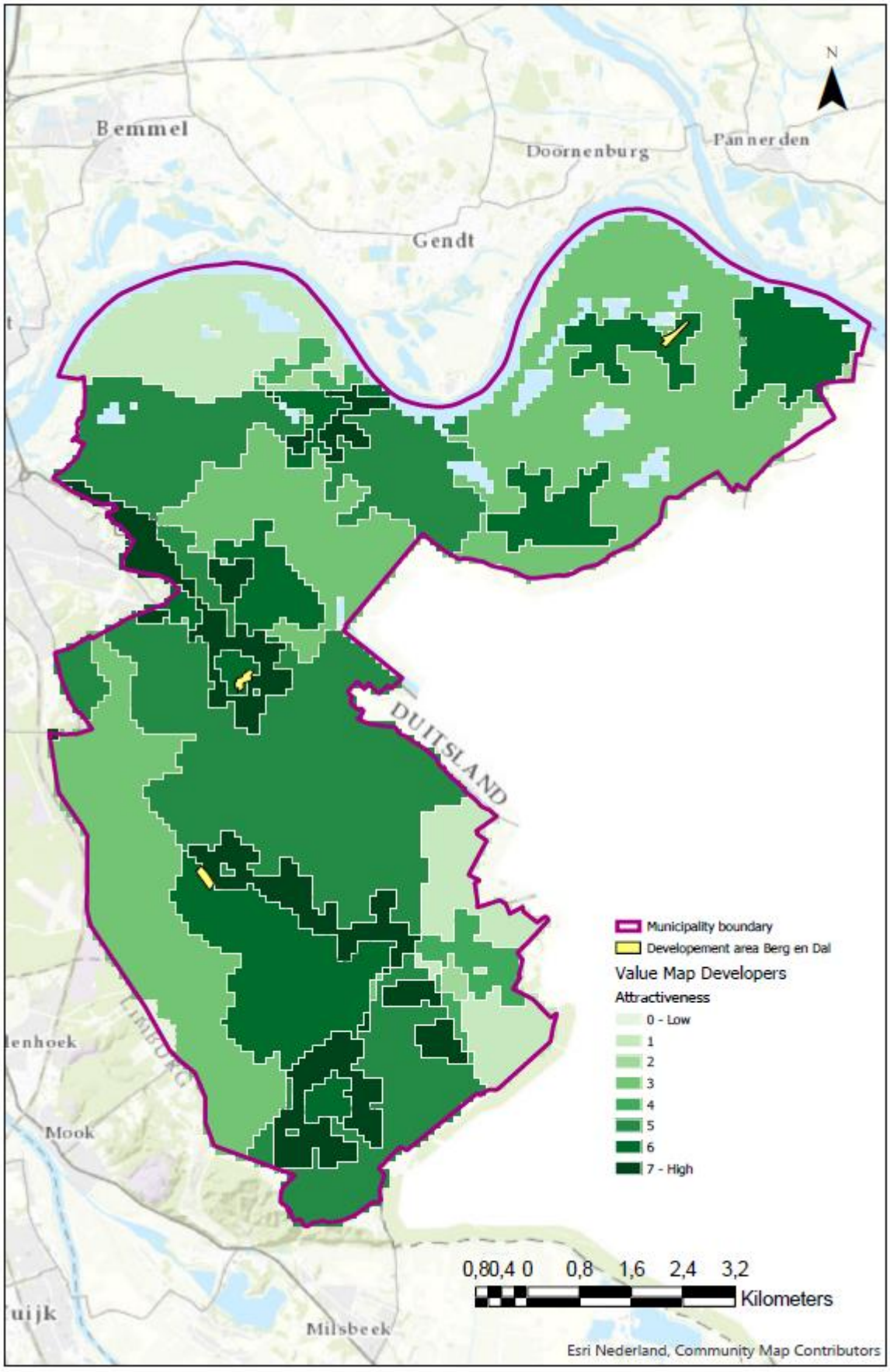

Figure 11: Value Map developer KloKGroep (click for an interactive map)
(https://geoplaza.maps.arcgis.com/apps/StorytellingSwipe/index.html?appid=47a5d)

Workshop

During a workshop, stakeholders negotiate the location and content of the development area with a multi-functional destination led by an independent moderator. Besides the Safety Region, the developer, also (future) residents, users (retail, service industry, medical care), traffic experts, local interest associations, urban planners, architects, ICT specialists, geographic scientists and environmentalists will participate. The early involvement of stakeholders in a workshop has the following advantages:

- - creating an understanding of each other's interests
- - knowledge sharing
- - better anticipating the possibilities and impossibilities in an area
- - avoid lengthy public participation procedures and permit procedures

Figure 12: Serious Game Underground (RO2, 2014)

An innovative and creative approach to a workshop can take the form of a serious game. With its formal and abstract formulations, game theory can be useful to provide solid micro-foundations for the study of collective decision-making processes and also social interactions, mainly related to the competition and cooperation among stakeholders (Elster, 1982, Lenferink S, Arciniegas G, Samsura A and Carton L., 2016).

By integrating background information about the area in the game (zoning plan, social demographic information and economic indicators), stakeholders can make well-founded decisions. The serious game calculates immediately what the consequences are for a specific interpretation of a selected area so that each stakeholder sees what the impact is and whether his interests are well represented. This should result in a well-founded and broadly supported decision for the choice and interpretation of a development area.

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