

Integrating geodesign and game experiments for negotiating urban development

SANDER LENFERINK, GUSTAVO ARCINIEGAS, ARY
SAMSURA, LINDA CARTON

Abstract

In this article we explore an expansion of geodesign to analyze processes of competition and cooperation by combining it with game-theoretical modelling and experiments. We test the applicability of facilitating these two fields in an integrated workshop by analysing the case study of oversupply of development sites in the Liemers corridor. Two workshops were held, with representatives of the six municipalities involved and with the regional and provincial authority, in which participants negotiated over the distribution of the supply of development sites. The workshops were performed around an interactive MapTable, with spatial information (from GIS) and financial information (from the game-theoretical model) being visualized in real-time. The integrated workshops were assessed to discover differences in terms of process and outcomes, and they examine whether and how learning takes place. We conclude that the combination of game theory and geodesign provides added value for planning support by facilitating a realistic discussion, and negotiation that is strongly connected to real-life locations, and by aiming at designing a common, collaborative solution. Through the integrated workshop learning about the problem of oversupply in financial and geographical terms and also about each other's motives and behaviour is stimulated.

KEYWORDS

Planning Support Systems (PSS); Geodesign; Spatial development; Collaborative planning; Negotiation game; Housing; Business areas

1. INTRODUCTION

After being widely introduced during the 2009 Annual ESRI International User Conference in San Diego, California, the concept of geodesign has attracted a lot of attention from different fields of study including geography, planning, landscape architecture, and environmental studies. The emphasis of geodesign has been on the entire design processes in geographical environments through stakeholder participation and collaboration with the aid of technology (Goodchild, 2010).

In this article we explore the application of an expansion of geodesign as an approach to analyse the cooperation and competition process among stakeholders by integrating the technique of spatial visualization with help of Planning Support Systems (PSS) with game-theoretical modelling and simulation in a workshop. We applied this approach in a case of regional planning with, at present, supply-led provision of sites for urban development in the Netherlands. At the moment, many Dutch municipalities experience problems of oversupply of plans for development sites caused by the increase of competition between municipalities and of the degree of inter-urban fragmentation as a result of the crisis in the financial and land market.

Since the combination of geodesign and game theory is still rare, in this article we aim to test the applicability of facilitating these two fields in an integrated workshop. In order to do so, we will first describe the theoretical background in the next section. Afterwards, the institutional setting and context of the project are described, followed by further elaboration of the analytical framework, the game theory model and the setup of the integrated geodesign-game-experiment workshops. Subsequently, the experiences with the workshops will be presented and discussed in more detail. Finally, we will provide our conclusions and some recommendations.

2. GEODESIGN AND GAME THEORY AS CORNERSTONES FOR INTEGRATED STAKEHOLDER INTERACTION

For the integrated workshop, two strands of theory are combined: Geodesign (1) and Game theory (2) on negotiations among stakeholders. In literature, geodesign is sometimes combined with the methodologies of serious games (for instance D'Aquino, Le Page, Bousquet, & Bah, 2003; Vasconcelos et al., 2009), but literature on the combination of game theory and geodesign is very scarce. This article aims to bring these separated strands together and report on an attempt to bridge and combine the two approaches. Therefore, this theoretical section will provide a glance into both geodesign and game theory.

2.1 Geodesign

While Geographic Information Science has a quantitative, rational-analytic reputation and is therefore criticized under headings like qualitative GIS (Cope & Elwood, 2009; Schoepfer & Rogers, 2014) and critical cartography (see Crampton & Krygier, 2006), geodesign generally adopts a more qualitative approach to facilitating collaboration between stakeholders.

According to the founder of the well-known framework for geodesign, Carl Steinitz, geodesign is an interdisciplinary practice, emerging from the collaboration of professionals and stakeholders, working jointly on a shared focal spatial problem or place. Steinitz' framework organizes and supports these practices, integrating various approaches and methods. Amongst others, the practice of geodesign requires collaboration of design professionals, analysts (often with a background in geographical sciences), information technologies and 'people of the place' (Steinitz, 2012, p. 4-5).

In an effort to catch the practices under the label of geodesign, the following definition has been formulated: "Geodesign is a design and planning method which tightly couples the creation of design proposals with impact simulations informed by geographic contexts, systems thinking, and digital technology" (Michael Flaxman, 2010, in Steinitz, 2012). In the project described in this article, a simulation game is developed and played with stakeholders, in a way which shows similarities to the approaches and practices described as geodesign. In an iterative process, researchers and stakeholders work towards representations of real-world landscapes, and modifications in its physical structure. A (GIS-based) PSS serves to bring various themes and information sets together, and calculate consequences of certain decisions 'on the fly' during deliberations and negotiations.

2.2 Game theory for strategic decision behaviour

In short, game theory can be defined as a mathematical approach to study strategic behaviour (Myerson, 1991). In game theory a game is an abstraction of conflicting and interdependent decision-making situations. 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, especially related to the competition and cooperation among stakeholders (Elster, 1982). Furthermore, game theory has the potential to improve our understanding of collective action problems by describing the basic structure of collective actions, explaining how collective actions work and analysing potential outcomes of collective actions (Hardin, 1971; Aumann, 1985; Ostrom, 1990).

Game theory is not a single method of analysis. Rather, it has numerous features for exposing and analysing various interactional structures of stakeholders in various contexts and dimensions. The various dimensions can include the number of stakeholders involved, the way in which the stakeholders interact, and the availability of information to the stakeholders, and these dimensions can notably affect both structure and outcome of stakeholders' interaction activities (Dixit & Skeath, 2004).

Despite its many advantages, game theory also has many limitations. One of them is that some of its basic assumptions are excessively rigid, which may give difficulties in its application to complex real-life situations. Related to social dilemmas (e.g. public goods provision), many studies and experiments have been performed (see e.g. Fehr & Gächter, 2000; Bochet et al., 2006). However, most of those experiments occurred in laboratory settings involving undergraduate students at universities (Henrich, Heine, & Norenzayan, 2010). The specificity of such experimental settings raises questions about their generalizability and the effect that context may have on experimental outcomes, especially when local and spatial settings are crucial, such as in the case of supplying development land. Moreover, most local decision-makers, particularly at the municipal level, are not always taking urban systems into consideration when they make their decision: they often only limit their concern to their municipal boundaries. By applying a geodesign workshop in conducting a game experiment with municipality representatives ("the real people of the place"), we might expect that the effectiveness of the experiment will be improved. Not only to observe their strategic decision behaviour in a more realistic setting, but it will also provide them with a better decision support.

3. CASE STUDY: MUNICIPAL OVERSUPPLY OF DEVELOPMENT SITES

3.1 Institutional setting

In the Netherlands, the planning of urban development primarily is a municipal task and responsibility. Municipalities apply zoning plans that specify whether and how much development is possible within their boundaries. In addition, municipalities attempt to attract investors and private developers for funding the developments because more development results in higher income from taxes. As a consequence, there is a considerable degree of competition between municipalities for attracting investors in urban development. The provincial government is left with the task to supervise and coordinate the municipalities and intervene if necessary. However, provinces usually tend to give freedom to the municipalities to plan for urban development by themselves.

Since the financial and real estate crisis has hit in 2008, it has become more important for municipalities in a region, in deliberation with the province, to reach a common understanding of the total demand for housing and office space; supply of development plans nowadays exceeds the total regional demand. If prices of land will drop because this oversupply of development plans will be brought to the market, then a ‘Tragedy of the Commons-situation’ (as originally explained in Hardin, 1968) will become manifest.

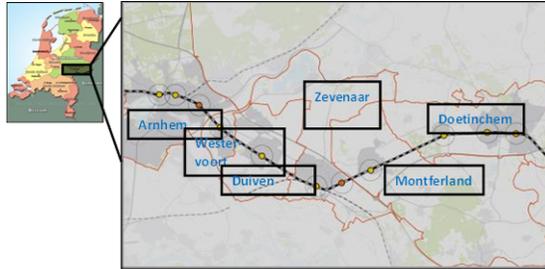


Figure 1. Municipalities in the Liemers transport corridor.

3.2 Case description

The case represented in the workshop is a real-world region with a problem of oversupply of development plans, anno 2014. In this article, we focus on the provision of locations for urban development in the case of the transport corridor between the Dutch cities of Arnhem and Doetinchem, the Liemers corridor (Figure 1), in the Eastern part of the Netherlands. In the Liemers transport corridor, connected by the A12 and A18 highways and the railway line Arnhem–Doetinchem, six municipalities compete by providing planned locations for future urban development. As a result of the competition and the limited demand for urban development at a regional scale, there is an oversupply of planned locations which considerably reduces the value of the locations (Table 1).

MUNICIPALITY	ARNHEM	WESTERVOORT	DUIVEN	ZEVENAAR	MONTFERLAND	DOETINCHEM	TOTAL REGIONAL SUPPLY	TOTAL REGIONAL DEMAND
Business area (ha)	12,0	3,0	33,5	20,2	27,0	113,0	208,7	120,1
Housing (no. units)	2000	536	682	1600	2057	2791	9666	8737

Table 1. Supply and demand of business area and housing in the Liemers Corridor until 2040. Based on EIB, 2013; IBIS-Province of Gelderland, 2013; Province of Gelderland, 2013.

The demand for future urban development can be regarded as a common pool resource. The six municipalities compete for this resource, and, in doing so, deplete the resource by providing for an oversupply of planned development. The solution to this problem can be found in a spontaneous collaboration (see Ostrom, 1990; Webster & Lai, 2003). An integrated geodesign workshop could provide for decision support to come to collaboration, by increasing insight in the problem at hand, simulation with potential solutions, and discussion of potential outcomes (e.g. Geertman, Stillwell, & Toppen, 2013). The set-up of such integrated workshops is described in greater detail in the next section.

4. METHODOLOGY: THE INTEGRATED GEODESIGN-GAME EXPERIMENT WORKSHOP

4.1 Analytical framework: Learning as a success criterion

As geodesign is understood as a team effort, group work criteria come into play for a successful project. In order for the workshop in terms of process and outcome to be successful, the geodesign team considered learning (individual and group learning) as the most important quality criterion for evaluating the project's success. This is in line with Vonk, Geertman & Schot (2005) and with Pelzer, Geertman, Van der Heijden, & E. Rouwette (2014) and Pelzer & Geertman, (2014), who made a systematic survey of added values of Planning Support Systems (PSS), eliciting communication and learning as proven, continuous elements, of successful group work with PSS for planning and decision-making. As learning should occur across disciplines, the four spheres of geodesign (Steinitz, 2012) should be incorporated in such a fashion that an iterative learning environment is created. We will now explain how we included these spheres as preconditions for enabling learning in the workshop.

The People of the Place sphere:

The workshop was not meant to simulate 'any region' or 'a fictitious problem', but concerns real stakeholders and a real-world planning problem, the oversupply of local development plans. In seeking an understanding of what stakeholders with real stakes do and think in weighing intervention dilemmas and in considering strategic cooperation and competition with other stakeholders in making their (individual and collective) trade-offs, their real-world situation should be represented in a recognizable fashion. A workshop setting requires sufficient simplification while remaining dedicated to the problem at hand. If the involved stakeholders would not consider it resembling their real-world situation, the developed approach would be considered a failure.

Geographic sciences sphere:

The research team acknowledged that a thorough inventory of plans and a trustworthy source of facts and figures would be necessary in order to make a valid, representative diagnosis of the problem. Data for preparing the workshops was collected with the involved stakeholders: the province, the metropolitan region and the six municipalities involved. We recognize the need for a thorough understanding of the spatial phenomenon being studied: the geography sciences sphere in Steinitz's spheres scheme. As in geography sciences, in this project the approach is premised on the idea to build a model based on the present, bearing sufficient accuracy, and then try to move it into the future.

Information technology sphere:

In early discussions about experimenting with decision-making in a workshop-setting with real participants, it was the intention that various expertises would be integrated. Planning support tools could be used to collect and represent (selective, 'what if') geographic information on local plans and area characteristics, while also incorporating or linking data on supply and demand of housing and business spaces (and related land prices and returns on investment). As the project unfolded, it became clear that the ideas for a negotiation game and the automated MapTable approach for visualizing dynamic simulations should be integrated. The negotiation game software would have the built-in pay-off structure of the underlying game-theory model, which calculates the financial consequences of various levels of (in-)equilibrium of supply and demand (section 4.2). The MapTable, running a dynamic GIS model (section 4.3), could serve as interface between the participants and the geographical information, as well as the game theory model in order to show financial consequences of decisions in real time. Based on previous experiences with collaborative planning and mapping processes and the MapTable instrument, there was a clear expectation on what could be represented in the short, compressed and simplified context typical for a game, how GIS visualizations could work in a workshop setting, and what would be (im-)possible in a collaborative setting with stakeholders (Mayer, Carton, De Jong, Leijten, & Dammers, 2004; Carton, 2007; Carton & Thissen, 2009; Arciniegas, 2012; Arciniegas & Janssen, 2012).

Design professions sphere:

It is in this sphere that the integrated workshop approach somewhat differs from that conceived by Steinitz (2012). For this particular project, dealing with an oversupply of plans, the financial-strategic negotiations between municipalities as to how to divide a burden of possible reduction of development plans, was considered the core issue. The exact outlook of the landscape

or the exact choices where spatial development plans should be decreased or cancelled, was considered of minor importance, when dealing with the strategic interactions among the stakeholders. On the contrary, their mutual negotiations and trade-offs between options of burden sharing, accepting losses, competition and cooperation, were found central to the intervention part of the geodesign effort. The preparation and execution of the workshops aimed at finding creative inter-relational solutions for the stakeholders and increasing the understanding of the strategic considerations of stakeholders and the workings of supporting approaches and instruments (see also Samsura, 2014). By offering various potential planning interventions and intervention instruments to the workshop participants in consecutive game rounds, incrementally increasing the complexity, creativity would be triggered in a step-wise fashion.

4.2 Game theory model

The game-theoretical model employed in this study is based on a modification of N-person prisoners' dilemma game that was done by constructing continuous payoff structure and strategy space to the agents/players. The basic idea of the game is that subjects or players – who in this study represented different municipalities in the Liemers transport corridor – individually choose how many development sites they are going to supply. With a limited demand that is shared among all players, the aggregated supply will affect the expected values from developing the sites. It is somewhat indubitable to assume that when the aggregate supply exceeds the demand, the value will decrease and oppositely, the value will increase when the aggregate supply is below the demand. Players will then have to negotiate to adjust their plans for development sites. Changes made to the supplies will trigger real-time calculations of financial outcomes as values for each municipality involved, using the equation:

$$p_i = x_i (r - (\sum x_i - D)c)$$

$$\text{for } 0 \leq x_i \leq s_i$$

In this equation, p_i is the financial outcomes of municipality i , which can also be negative. The number of development locations, x , supplied by municipality i (in ha) is the only variable to be decided by the players. The other variables are given constants and consist of: r , the basic revenue based on specific cost and selling prices of every unit of development location in that particular municipality (in €); and D , the total demand for development locations in the corridor (in ha). When $\sum x_i$, the aggregated supply of development locations (in ha), is greater than D (i.e. there is oversupply), c is the

reduction factor for the value of the municipalities development sites. Adversely, when Σx_i is smaller than D (there is undersupply), c is the increasing factor for the value of each development site. Theoretically, the optimum level can be calculated by maximizing Σp_i . The constants were gathered and calculated based on real data related to the cost and selling price of location development for each municipality and also on reports from the province and city-region authority that covers the study area (CBS, PBL and Wageningen UR, 2013; Cobouw, 2013; EIB, 2013; IBIS-Province of Gelderland, 2013; Province of Gelderland, 2013; VU University Amsterdam, 2011). Therefore each municipality has different values of x , r and c , based on their plans and profiles of costs and benefits structure related to their location development. Moreover, each municipality also has a maximum supply of development sites, s_i , based on their current development plans.

4.3 MapTable PSS workshop

Two geodesign workshops were organized, in which negotiations between the six municipalities were facilitated using financial and geographical data on residential and industrial developments. The first workshop was held with the regional urban development practitioners working as civil servants in the provincial government or city-region authority related to the Liemers transport corridor. In this workshop, we asked the participants to play the role of a representative of a municipality in the corridor. The second workshop was held with the local urban development practitioners from each of the six municipalities in the corridor. Each workshop was held as a semi-controlled experiment. Both workshops were videotaped with the purpose of assessing the participants' statements, observing their physical behaviour, and analysing the relation between the two, because people do not always behave according to rational principles (Neale & Bazerman, 1985), and the negotiation process defines how and why people have their particular way of thinking and acting (Rubin and Brown, 1975).

The MapTable PSS

A PSS with a digital map of the corridor area was constructed, which featured an integration of two main elements: an interactive GIS, a digital touch table, called the MapTable, and the game theory model, described above. As such, the PSS is a combination of what Schoop (2004) describes as an automation-oriented system, that tries to find any economic optimum of a negotiation process, and a communication-oriented system, that supports communicative processes. The MapTable is a digital touch table of large format (46-inch) developed and commercialized by the Dutch firm Mapsup (<http://www.mapsup.nl>) designed to support group work around spatial information. The PSS was developed within the ESRI ArcGIS® environment using an

ArcGIS extension called CommunityViz (<http://www.communityviz.com>). The extension CommunityViz is used to support users performing map-based calculations (Walker & Daniel, 2011), showing the results of their decisions in real time (Figure 2). The interactive interface and tools for the experiment were developed in cooperation with Mapsup.



Figure 2. Players negotiating around the MapTable PSS.

In the PSS, the supply of development plans is visualized using building blocks that represent a fixed amount of developments units (Table 2). The amount that is represented was chosen to easily alter the supply by each municipality. The initially displayed spatial distribution of blocks was modelled to match the current supply of both business and housing by each municipality, both in size and geographical location (Figures 3 and 4).

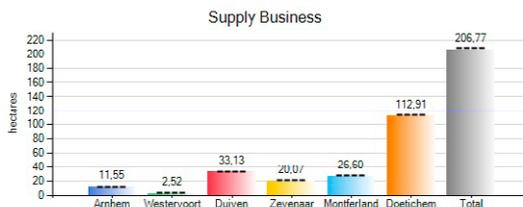


Figure 3. Initial distribution of supply of business areas. The blue line indicates demand for business areas in the corridor. Dashed lines on each bar indicate the single local supply for each municipality.

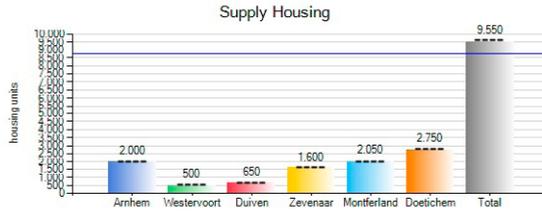


Figure 4. Initial distribution of supply of housing. The blue line on both charts indicates demand housing in the corridor. Dashed lines on each bar indicate the single local supply for each municipality.

TYPE OF BLOCKS	LARGE	SMALL
Business area (ha)	5,0	0,5
Housing (no. units)	200	50

Table 2: Representation of housing and business area by visualized types of blocks.

The PSS shows financial effects of a given spatial configuration of spatial developments (for both business and housing), by presenting a financial figure, in Euros, for each municipality separately and an aggregate value for the corridor (Figures 5 and 6).



Figure 5. Financial impacts for the initial supply distribution for projected business areas.

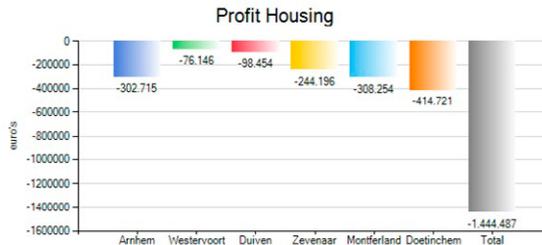


Figure 6. Financial impacts for the initial supply distribution for projected housing developments.

Workshop participants used the PSS to assess financial impacts of the initial spatial configuration of projected housing and business development, negotiate changes, and adjust their individual supply on the MapTable using their finger or a digital pen. They could either remove blocks, add blocks or by moving blocks from one municipality to another (by selecting one or more blocks within the municipal boundaries of one player and dragging this selection within the boundaries of a target municipality). If the participants changed the spatial configuration for spatial development, the financial figures were automatically reassessed in real time.

Workshop setup and game rounds

The workshops started with an introduction to the study area and the role of PSS. Next, a hands-on practice demo and instruction with the MapTable Planning Support System (abbreviated underneath simply as PSS) was given, which included:

- Map layers available in the PSS (municipal boundaries, spatial development plans, railway stations, roads, water bodies, aerial photography)
- Introduction to working with the library of blocks
- Charts showing supply of spatial plans
- Charts showing financial revenues for business and housing.

Subsequently, participants carried out four rounds of assignments in 2.5 hours involving negotiations about downsizing supply of plans (round 1), while taking into account public transport (round 2), new railway station development (round 3) and introduction of a financial compensation mechanism. The overall goal was to: “Modify the spatial configuration of supply of municipal development plans for 2025 using the profits displayed at both the individual municipal level and the corridor level”.

At three moments in the workshop participants filled in a short questionnaire regarding their expectations about the workshop, and experiences with the tool, as illustrated in the timeline of the workshop in Figure 7.

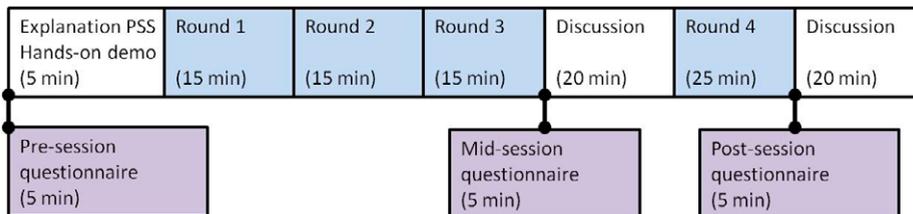


Figure 7. Timeline representing the experiment protocol of one workshop session.

5. RESULTS: EXPERIENCES FROM PARTICIPANTS

In this section, we describe the experiences from applying the workshops. We do this by highlighting the learning experience (section 5.3). However, first we describe the general observations on the performance of the visualisation and financial model (section 5.1) and the differences in process and outcomes between the workshops (section 5.2).

5.1 General observations

In general, the fact that the negotiation took place around an interactive map proved to be effective. It facilitated a focused form of communication, in which financial and spatial negotiations could be combined and supported by relevant information in order to come to an agreement. The tool helped to identify first steps towards obtaining a better regional adjustment of supply and demand in municipal locations for development and overcoming the common pool resource problem.



Figure 8. Stakeholders pointing to the map during their negotiations. Municipality territories are represented by different semi-transparent colours on the map, and the various graphs visualize the distribution of supply and demand for housing and office space.

All participants pointed to relevant features on the map in trying to explain their motives and justify their behaviour (Figure 8). In doing so, they used in-depth knowledge of their respective municipalities and brought forward spatial arguments to justify their behaviour. For example, in one of the workshops, the municipality of Zevenaar brings forward the importance of the international industrial area along the A12 highway, by zooming in on the

location, turning on the underlying high-resolution aerial photography, and explaining the relevant geographical relation to the highway and the German hinterland.

Nevertheless, some of the participants felt that the broader spatial discussion on urban development was missing in the workshops. They felt that discussion with the tool “become too much of a financial story, and the spatial planning aspects are insufficiently discussed”. The participants felt the urge to discuss more spatial aspects, look at more background maps, and illustrate that with issues, chances and opportunities in their own municipality. The set-up of the workshop did, however, force them to focus solely on issues related to oversupply. This was felt by the participants as too restrictive. For some participants, the financial information seemed to fuel the discussion more than the geographical information. Such remarks indicate that the integration of spatial information (central in geodesign) and financial information (put central in this game, using an N-prisoners dilemma conceptualization) needs to be balanced.

The relation between the financial model and the spatial information must be clear and transparent, according to the participants. They need to be aware of the preconditions and assumptions, which information is displayed, and which factors are included and excluded in the model, to be able to design the outlines of an agreement. As a participant notes in the questionnaire, in order for the negotiation to work, “insight in the figures is essential for a realistic negotiation”. However, it is especially important for them to realize that the financial model simplifies financial relations in the real estate market, and that, as such, the exact outcomes are not of great added value. After all, the goal of the workshop was not primarily to simulate possible outcomes on the basis of a model, but to facilitate a discussion on the issue of oversupply of locations. This was clear to the participants, and the workshop was successful at it, as illustrated by this quote: “the tool helps to structure the discussion, specify each other’s interests and subsequently confront each other”.

5.2 Process and outcomes

The process and outcomes differed greatly between the two workshops, although it has to be stated that participants acknowledged the added value of both workshops.

Workshop with regional participants

In the workshop with the regional and provincial government, the participants easily reached an agreement on the amount of development locations to be supplied. It was commonly agreed that a general decrease of

locations would help the financial result of all players, and that the largest suppliers should cut back their plans the most. This can be qualified as realistic, because of the regional perspective of the players in this workshop in which local sensitivities did not play a role: all players more or less acted in the common, regional interest. This can also be seen during the workshops: the participants displayed active poses and tried to look for possibilities, both within and outside their respective, assigned municipalities.

The iterations in the workshop merely helped to indicate whether the common regional interest was being served. The participants decided together what the best strategy was to reach the objective of limiting oversupply. The participants iteratively explored the limits of the model, and through trial-and-error the objective of limiting the regional oversupply was reached and distributed fairly over the different municipalities.

The main outcome of the workshop can be formulated as increased insight in the size and nature of the problem of regional oversupply, and the cross-municipal character of it. For now, the regional and provincial authorities still feel that the municipalities should solve the problem. After all, “the municipalities have caused the problem, they are feeling the consequences of it, so they should also increase their effort in solving it”.

Workshop with local participants

For the participants in the workshops with the local municipalities, this proved to be different. They could not come to a limitation of the supply of development locations. At the end of the negotiation an oversupply of these locations still existed. The negotiations with the players from the local municipalities had a tougher character in which participants negotiated more from a local perspective, serving their own local interests. Each player pointed to other municipalities to find solutions for the problem of oversupply. They used the map to identify and discuss locations in the neighbouring municipalities that otherwise might be overlooked.

The iterations in the Maptable PSS were used more restrictively than in the workshop with regional participants. They applied a drip-feed method, in which only small decreases were made to the amount of locations provided. Instead, the participants used the Maptable more as a discussion tool for explicating each other’s position in the negotiation.

The main outcome of the process was a call for more provincial involvement in formulating overarching spatial policies on regional urban development: “the province will have to deliver more tailor-made approaches. They

have the instruments to intervene, why not do so? The province should carefully assess each municipal plan”. Although the workshop successfully brings information together in interactive fashion with plenty of (financial) feedback, which can be used by the participants to design solutions to the problem of oversupply, this seems not to be sufficient for finding a solution to the problem of oversupply in this case study.

5.3 Learning

Although the workshops yielded different results as to reaching agreements (see Section 5.2), the added value of the integrated PSS for the various tasks was apparent to all players involved. The combination of the interactive map and real-time finances stimulated a discussion of the information. Participants questioned each other on the proposed plans and, especially, on the motives behind these plans. This is illustrated by remarks made in the questionnaire: “The tool effectively brings motives to the surface”, and in the plenary discussion: “It is insightful. It relates to the essence of collaboration, which is crucial. It is a good tool to do so”. The information technology offered a direct insight in each other’s current situation and future plans. Therefore both learning about the position of other stakeholders, as learning about the issue at hand (the problem of oversupply in the Liemers corridor) occurred (Table 3).

	MINIMUM	MAXIMUM	MEAN	STD. DEVIATION	CRONBACH'S A
Learning about other participants	1,67	6,67	5,17	1,21	0,74
Learning about the issue	2,67	6,33	5,26	5,26	0,92

Table 3. Results of the objective to learn about others and the object at hand (N = 14; On a 7-point Likert scale with 1 = strongly disagree; and 7 = strongly agree)

The participants stressed that the tool effectively linked financial and spatial negotiations, which are usually taking place in separated arenas. The players used both the map and the financial data provided in the negotiation process. Especially the information from other municipalities, often belonging to other regions, proved to be useful. As one participant explains: “The extra information of the spatial element of the corridor versus the region is underdeveloped in negotiations in practice. That is information from another area and therefore usually invisible. As a municipality, you spend too little time looking around you to find out where the organizations and developments are that are essential for the success of your own plans”.

The differences between the negotiation results of the workshops could point to the conclusion that the participants display real behaviour. The realistic character of the integrated workshop seems to trigger the behaviour that can also be observed in practice: at a regional level, one can find a solution for oversupply, but at the local level this seems much harder. The realistic character of the workshop was also stressed in the plenary discussion: “The workshop was very insightful. It is close to reality. It is not a fictive case, with the map and the locations. I think that helps a lot: you have to make it real”.

6. CONCLUSIONS AND RECOMMENDATIONS

In this article, we tested the applicability of facilitating both geodesign and game theory in an integrated workshop. We explored this for the Dutch case of oversupply of planned sites for urban development in the Liemers corridor. We specifically examined the way in which the integrated workshop can stimulate learning.

We can conclude that the combination of game theory and geodesign provides added value for planning support: it creates a realistic discussion and negotiation strongly connected to real-life locations, aimed at designing a common, regional solution. Participants learn about the problem and about each other through the provided interactive geographical and financial information.

The interactive tool especially proved to work well for generating insight in and learning about the issue at hand and each other’s motivation. The integration of geodesign and game theory therefore helps to add the contextual discussion of geodesign to game theory, while simultaneously it adds the financial strategic behaviour of game theory to the geodesign. The results, in the form of the distribution of locations and financial outcomes, merely served for making the negotiation more realistic, stronger spatially grounded and better supported by facts. The greatest added value lies in the insight generated in the process behind the outcome: e.g. how do municipalities interact, react to each other, and respond to changing circumstances? This seems to be in line with Lee (1994) and Te Brömmelstroet (2012), who argue that some problems are better approached through broad generalizations than through detailed models. This should be taken into account when considering the greatest disadvantages of the integrated workshops: the models applied offer a considerable (financial) simplification of reality. Therefore, the outcomes of the negotiations can only be used at a very general level.

In addition, the transferability of the integrated workshop is currently limited because the game-theoretical model is only applicable to settings in

which an N-person prisoners' dilemma occurs. In its current form, it can only be used to analyse strategic behaviour in such settings. However, the integrated workshop may serve as an initial evidence of the possibility to integrate game-theoretical modelling and experiment with geodesign. By changing the structural variations in the game-theoretical model, we can analyse different situations. Moreover, we can also increase the complexity of a game in order to make it closer to reality. We strongly believe that the integration of game-theoretical modelling with geodesign may offer a promising approach for analysing complex urban development processes, because it particularly can take into account a specific interdependent situation among stakeholders in the process and the results of the analysis can be validated empirically through experiments with real stakeholders as we have done in this research.

Based on our work, several avenues for further research can be distinguished. The first is a further exploration of the potential of this tool. The tool proved to be useful in the first stages of a negotiation process, when information needs to be communicated efficiently. The application of the PSS in a later stage would require more in-depth information, and more sophisticated financial and spatial modelling. A second avenue is to broaden the sector in which the tool is applied. A cross-sectoral comparison could help to identify crucial preconditions in negotiations: e.g. what is the challenge central in a specific context and situation, which information is necessary for decision-making, how many players can be included in the strategic process, how could the strategic social interactions be included in the geodesign-negotiation-game workshop, and how can the problem best be visualized in the PSS.

We would like to thank all partners involved to support or cooperate in this project, including: Mapsup (Jaap de Kroes) and Noordzuiden (Winona Rijs and Edwin van Uum) for the development and execution of the workshops, all stakeholders from the six municipalities in the Liemers corridor and other stakeholders (province of Gelderland and city-region Arnhem-Nijmegen) for playing the game with us; and NWO (for funding the project in the Urban Regions of the Delta and iTOD programs).

REFERENCES

- Arciniegas López, G. A. (2012). Map-based decision support tools for collaborative land use planning (PhD thesis). VU University, Amsterdam. Retrieved from <http://dare.uvu.nl/handle/1871/39296>
- Arciniegas López, G. A., & Janssen, R. (2012). Spatial decision support for collaborative land use planning workshops. *Landscape and Urban Planning*, 107(3), 332-342.
- Aumann, R. J. (1985). What is game theory trying to accomplish? In: K. J. Arrow, & S. Honkapohja, (Eds.), *Frontiers of Economics*. Oxford, United Kingdom: Basil Blackwell.
- Bochet, O., T. Page, and L. Putterman. 2006. "Communication and Punishment in Voluntary Contribution Experiments," *Journal of Economic Behavior and Organization*, 60 (1), 11-26.
- Carton, L. J. (2007). Map making and map use in a multi-actor context. Spatial visualizations and frame conflicts in regional policymaking in the Netherlands (PhD thesis). Delft, University of Technology. Available online at <http://repository.tudelft.nl/view/ir/uuid%3Af5821d4b-5299-4af9-baad-176dbf-1daabb/>
- Carton, L. J., & Thissen, W. A. H. (2009). Emerging conflict in collaborative mapping: towards a deeper understanding? *Journal of Environmental Management*, 90(6), 1991-2001.
- CBS, PBL and Wageningen UR (2013) Compendium voor de Leefomgeving. Retrieved from <http://www.compendiumvoordeleefomgeving.nl/>
- Cobouw (2013) Bouwkosten – Kosteninformatie. Retrieved from <http://bouwkosten.kosteninformatie.nl/whitepapers-van-kosteninformatie>
- Cope, M., & Elwood, S. (Eds.). (2009). *Qualitative GIS: A Mixed Methods Approach*. London, United Kingdom: Sage.
- Crampton, J. W., & Krygier, J. (2006). An Introduction to Critical Cartography. *ACME: An International E-Journal for Critical Geographies*, 4(1), 11-33. Retrieved from <http://ojs.unbc.ca/index.php/acme/article/view/723/585>
- D'Aquino, P., Le Page, C., Bousquet, F., & Bah, A. (2003). Using Self-Designed Role-Playing Games and a Multi-Agent System to Empower a Local Decision-Making Process for Land Use Management: The SelfCormas Experiment in Senegal. *Journal of Artificial Societies and Social Simulation*, 6(3). Available from <http://jasss.soc.surrey.ac.uk/JASSS.html>
- Dixit, A. K. and Skeath, S. (2004). *Games of strategy*. New York: W. W. Norton & Company.
- EIB, Economisch Instituut voor de Bouw (2013). *Verkenning woningbouwprogrammering regio Arnhem-Nijmegen*. Retrieved from http://www.eib.nl/pdf/verkenning_woningbouwprogrammering_regio_arnhem_nijmegen_KT.pdf
- Elster, J. (1982). Marxism, functionalism and game theory. The case for methodological individualism. *Theory and Society*, 11(4), 453-482.
- Fehr, E., & Gächter, S. (2000). Cooperation and Punishment in Public Goods Experiments, *American Economic Review*, 90(4), 980-994.
- Geertman, S., Stillwell, J., & Toppen, F. (Eds). (2013) *Planning Support Systems for sustainable urban development*. Heidelberg, Germany: Springer.

- Goodchild, M. F. (2010). Towards Geodesign: Repurposing Cartography and GIS? *Cartographic Perspectives*, (66), 7-22.
- Hardin, G. (1968). Tragedy of the commons. *Science*, 13 December 1968, 1243-1248.
- Hardin, R. (1971). Collective Action as an Agreeable n-Prisoners' Dilemma. *Behavioral Science*, 16(5), 472-481.
- Henrich, J., Heine, S. J., Norenzayan, A. (2010). The weirdest people in the world? *Behavioral and Brain Sciences*, 33(2-3), 61-135.
- IBIS-Province of Gelderland (2013). Voorraadgegevens bedrijventerreinen Gelderland per 1-1-2013. Available online at <http://www.gelderland.nl/bedrijventerreinen>.
- Lee, D. B. (1994). Retrospective on large-scale urban models, *Journal of the American Planning Association*, 60(1), 35-40.
- Mayer, I.S., Carton, L. J., De Jong, M., Leijten, M., & Dammers, E. (2004) Gaming the future of an urban network. *Futures*, 36(3), 311-333.
- Myerson, R. B. (1991). *Game Theory: Analysis of Conflict*. Cambridge, MA: Harvard University Press.
- Neale, M. A. & Bazerman, M. H. (1985). The effects of framing and negotiator overconfidence on bargaining behaviors and outcomes. *Academy of Management Journal*, 28(1), 34-49.
- Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge, United Kingdom: Cambridge University Press.
- Pelzer, P., Geertman, S, Van der Heijden, R., & Rouwette, E. (2014) The added value of Planning Support Systems: A practitioner's perspective. *Computers, Environment and Urban Systems*, 48, 16-27.
- Pelzer, P., & Geertman, S. (2014) Planning support systems and interdisciplinary learning. *Planning Theory and Practice*, 15(4), 527-542. doi: 10.1080/14649357.2014.963653
- Province of Gelderland (2013) Omgevingsvisie Gelderland. Retrieved from <http://www.ruimtelijkeplannen.nl>
- Rubin, J., & Brown, B. (1975). *The social psychology of bargaining and negotiation*. New York, NY: Academic Press.
- Samsura, D.A. (2014). *Games and the city* (Doctoral Thesis). Radboud University, Nijmegen.
- Schoepfer, I., & Rogers, S. (2014). A New Qualitative GIS Method for Investigating Neighbourhood Characteristics Using a Tablet. *Cartographica: The International Journal for Geographic Information and Geovisualization*, 49(2), 127-143.
- Schoop, M. (2004, June). The Worlds of Negotiation. In *Proceedings of the 9th International Working Conference on the Language-Action Perspective on Communication Modelling (LAP 2004)*, (pp. 179-196).
- Steinitz, C. (2012). *A Framework for Geodesign: Changing Geography by Design*. Redlands, CA: ESRI Press.
- Te Brömmelstroet, M. (2012). Transparency, flexibility, simplicity: From buzzwords to strategies for real PSS improvement. *Computers, Environment and Urban Systems*, 36(1), 96-104.
- Vasconcelos, E., Lucena, C., Melo, G., Irving, M., Briot, J. P., Sebba, V., & Sordoni, A. (2009, October). A Serious Game for Exploring and Training in Participatory Management of National Parks for Biodiversity Conservation: Design and Experience. In *Games and Digital Entertainment (SBGAMES), 2009 VIII Brazilian Symposium on* (pp. 93-100). IEEE. Retrieved from <http://www-ia.lip6.fr/~briot/cv/SimParc-SBGAMES09-IEEE.pdf>
- Vonk, G., Geertman, S., & Schot, P. (2005). Bottlenecks blocking widespread usage of planning support systems. *Environment and Planning A*, 37(5), 909-924.
- VU University Amsterdam (2011). *Land rents – determination of land rents for the Netherlands*. Department of Spatial Economics & Spatial Information laboratory, Amsterdam.
- Walker, D., & T. Daniels, T. L. (2011). *The Planners Guide to CommunityViz: The Essential Tool for a New Generation of Planning*. American Planning Association, APA Planners Press
- Webster, C. & Lai, W.C.L. (2003) *Property Rights, Planning and Markets: Managing Spontaneous Cities* (Cheltenham, Edward Elgar).

