OTB – Research for the Built Environment
Faculty of Architecture and the Built Environment

Research Programme 2014-2018

TU Delft Delft University of Technology

Challenge the future

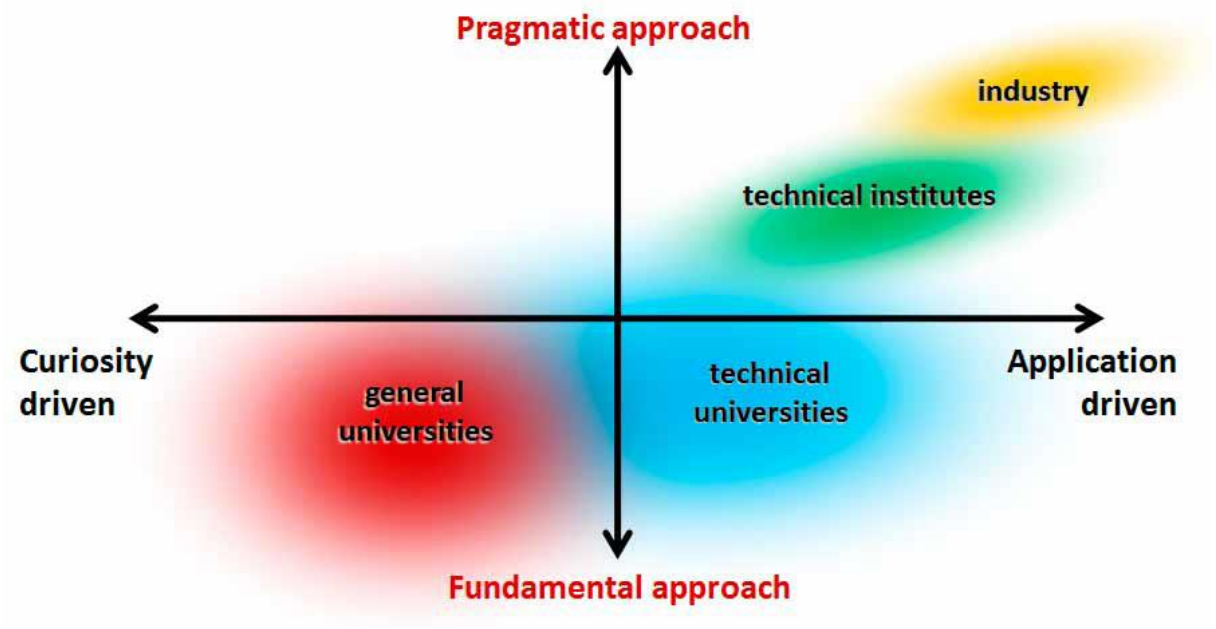
Contents

1 Introduction

OTB Research for the Built Environment is now a department of the Faculty of Architecture and the Built Environment. Until May 2013 it was an interfaculty research institute of the faculty of Architecture, the faculty of Technology Policy and Management and the faculty of Civil Engineering and Geo-sciences. As an Interfaculty Research Institute it had an independent status within Delft University of Technology, it fell directly under the responsibility of the executive board of the university (CvB) and it functioned as an autonomous unit within Delft University of Technology.
The merging of the OTB and the faculty of Architecture was a result of the review process (herijking) of the university's teaching and research activities and its support framework which was started by the executive board in 2009. This review process was deemed necessary to ensure the long-term continuity and quality of TU Delft's academic profile and its leading position on the international stage. Main goal of the merger between the Faculty and Architecture and OTB was to strengthen the research portfolio of the Faculty of Architecture and to establish more collaboration in the domains of research and education between both organizations. Since the merger, the faculty is renamed in the faculty of Architecture and the Built Environment.

Mission and research area
The OTB's research covers the areas of housing studies, urban and regional studies, and geoinformation technology and governance studies. The research activities deal with the built environment, and refer to aspects of the technical sciences, the policy and management sciences, the behavioural sciences, the spatial disciplines and the application of information and communications technology. This research profile is directly connected to the mission of the department to conduct strategic research on the built environment in which both a fundamental understanding and the application of results are central objectives. More specifically, the interplay between scientific driven questions and societal issues forms a key element of the research.
The main objective of OTB is to perform strategic research in the areas of housing studies, urban and regional studies, and geo-information technology and governance studies. This type of research, which can be described as 'investigating utility-driven questions in a fundamental way', is positioned between fundamental and applied research, see figure 1. It is directly related to the mission of the faculty of Architecture and the Built Environment and the mission of TU Delft.

This means that the input for the research often comes directly from societal problems (for an elaboration see the Research Programmes in the subsequent chapters). Also the application of the results is an important objective of the research. This does not imply, of course, that researchers at the department OTB do not conduct fundamental and applied research. Often they are the start (fundamental orientation) or the result (applied orientation) of strategic research. So, besides a fundamental orientation aimed at understanding, design, innovation and evaluation are also part of the research activities at OTB. Since application-driven fundamental research looks at both fundamental understanding as well as considerations of use, the output of this type of research is broader than in the case of pure fundamental research. Valorisation in the form of, for instance, professional publications and publications aimed at the general public forms an essential part of application-driven fundamental research.



The research activities of OTB have both an international and a national scope and are often multi-disciplinary. The research activities of OTB are organised into three research programmes:

I. Housing in a Changing Society, which aims at developing knowledge on measuring energy efficiency, affordability and consumer preferences, knowledge on the effects of policies aimed to achieve sustainable and affordable housing, and knowledge on the function of the housing market by developing price models and analysing the management and governance of actors in the housing markets (programme coordinator: Prof. Marja Elsinga).
II. Urban and Regional Studies, which is about the interrelationships between the everyday social and spatial patterns, growing complexities and governance of neighbourhoods, and cities and regions (programme coordinator: Prof. Maarten van Ham).
III. Geoinformation Technology and Governance, which aims at geo-serving the networked society via top quality research on Geoinformation Technology and Governance directed at a sustainable Spatial Data Infrastructure (programme coordinator: Prof. Peter van Oosterom).

These programmes have recently been formed and are combinations of the six previous research programmes of OTB. The old programmes Housing Systems and Housing Quality formed the new programme Housing in a Changing Society. Urban and Regional Studies is a combination of the old programmes Urban and Regional Development, Neighbourhood Change and Housing and part of the programme Governance of Geoinformation and Land Development, while the other part of this programme formed the programme Geoinformation Technology and Governance together with the previous programme GIS Technology.
Within the three programmes the research is organised into a number of sub-programmes. A complete overview of the research groups is given in table A. The departments of OTB and Real Estate and Housing cooperate in the Housing programme.

Table A: Research programmes, sub-programmes and research leaders

Research programme	Sub-programme	Sub-programme leader
Housing in a Changing Society Programme coordinator: Marja Elsinga	Housing Markets Housing Governance Housing Management Housing Quality	Peter Boelhouwer Marja Elsinga Vincent Gruis Henk Visscher
Urban and Regional Studies Programme coordinator: Maarten van Ham	Governance of Land development Territorial Governance Urban and Neighbourhood Change Urban Systems and Transport	Willem Korthals Altes Dominique Stead Maarten van Ham Kees Maat
Geoinformation Technology and Governance Programme coordinator: Peter van Oosterom	Geoinformation Governance Geoinformation Technology	Bastiaan van Loenen Peter van Oosterom

Cooperation between research programmes
Although each of the research programmes has its own focus and research themes, which form the main reason for dividing up the research of OTB into three programmes, these programmes also cooperate with each other. These collaborations are shown in table B, in which X means actual cooperation and (X) potential collaboration.

Resources and Funding
The achievement of many of the goals that OTB had set itself for the past decade was partly facilitated by the institute's participation in long-term national and international research programmes. Since the university's review process, that leads to the merging of OTB and the faculty of Architecture and the Built Environment, there was a 20% reduction of OTB's direct funding by the university. These long-term research programmes have now become even more essential for the continuation of the research activities of the department and for the appointment of new PhD students. So, OTB puts a lot of effort in trying to acquire long-term research funding from institutions such as EU, NWO and STW and is eager to establish a good balanced relationship between directly funded and contract based activities.

Table B: Cooperation between research programmes

		HOUSING				URBAN AND REGIONAL STUDIES				GiTG	
		Market Dynamics	Govern-ance	Organisa-tional Strate-gies	Housing Quality	Govern-ance of Land Develop-ment	Territori-al Govern-ance	Urban and Neigh-bour-hood Change	Urban Systems and Transport	Geoinfor-mation Govern-ance	Geoinfor-mation Technol-ogy
HOUSING	Market Dynamics		X	X	X	X					
	Governance	X		X	X						
	Organisational Strategies	X	X		X						
	Housing Quality	X	X	X							
U&RS	Governance of Land Development	X	X		(X)		X	X	X	X	
	Territorial Governance		(X)			X		X	X		
	Urban and Neighbourhood Change	X	(X)	(X)		X	X		X		X
	Urban Systems and Transport					X	X	X			X
GiTG	Geoinformation Governance										X
	Geoinformation Technology					X	X	X	X	X	

2 Housing in a Changing Society

2.1 Introduction to the programme

2.1.1 Mission and research area

Vision: A sustainable fit between the demand for and the supply of housing is of major importance for the quality of life of its occupants, for the ecological footprint of urban areas and in terms of economic assets. Achieving such a sustainable fit requires innovative, multidisciplinary scientific research.

Mission: The mission of the programme is to develop scientific knowledge that is relevant to society. That is, the programme is intended to foster knowledge about measuring energy efficiency, affordability and consumer preferences; about the effects of policies aimed at achieving sustainable and affordable housing; and about the functioning of the housing market. The mission is pursued by developing price models and analysing the management and governance of actors in the housing markets. By using multidisciplinary approaches, the programme can generate new scientific insights through a combination of five scholarly perspectives: technology, policy sciences, management sciences, economy and sociology.

Objectives: The programme seeks to make fundamental contributions to the scientific fields that are related to achieving a sustainable fit between the demand for and supply of housing, to contribute to the innovation of the educational curricula and to produce insights that are beneficial to the societal debate on housing. The programme consists of four sub-programmes – Market Dynamics, Governance, Organisational Strategies, and Housing Quality – through which it aims to be a key player at the international level and a front-runner at the national level. Therefore, the following key objectives have been formulated for each of the sub-programmes:

- Market Dynamics: to study the structure and functioning of the housing and house-building market by focussing on demand, supply and price and their interdependence.
- Governance: to investigate policies for sufficient, affordable and secure housing and the impacts of those policies on welfare and economic growth.
- Organisational Strategies: to develop and evaluate approaches for the management and redevelopment of the housing stock in order to strengthen the socioeconomic and environmental sustainability of housing provision.
- Quality: to study the physical performance of housing – such as energy efficiency, ecological sustainability and indoor climate – and policy instruments that guarantee or improve such performance.

2.1.2 Updating and merging of previous programmes

The research group Housing in a Changing Society (the Housing group) is the result of a merger of two previous research programmes, namely Housing Systems and Housing Quality. All aspects of housing have thereby been brought together in one research group. This new group can benefit from more cooperation at the meeting points of the two former research programmes. For example, the former Housing Quality group had a thorough technical knowledge of energy efficiency and the aims of policymakers. Again and again, it

showed that the ambitions of policymakers proved to bear little resemblance to the energy efficiency improvements that were taking place in practice. In addition, the knowledge that the Market Dynamics group has developed on consumer preferences can now be fed into housing management strategies.

The figure below depicts the rationale for the division into four sub-programmes. Challenges in the field of housing are expressed as gaps between supply and the changing demand (Market Dynamics, part of the former Housing Systems). To steer or to accommodate these changes, various institutions intervene on the housing market (Governance, part of the former Housing Systems). Individual actors (landlords, owners, developers, contractors) adapt housing within the market and institutional context (Organisational Strategies, part of the former Housing Quality), resulting in the physical adaptation of housing (Quality, part of the former Housing Quality), to meet social, economic and environmental demands. To address societal challenges, the four sub-programmes will increasingly need to cooperate.

2.1.3 Scientific relevance

Housing, as an area of scientific study as well as a societal activity, requires productive interactions between several disciplines. Furthermore, because housing is continuously influenced by developments in society as well as by scientific insights, research in this area has to both anticipate and respond to changes in context and knowledge. Therefore, the programme investigates this topic from many different angles and combines several scientific disciplines:

- In the Market Dynamics group, the disciplines of economics and psychology dominate the research on the functioning of the housing market, in keeping with the ambition to develop advanced models of the housing market.
- In the Governance group, policy sciences, economics and sociology dominate the efforts to understand the governance of housing and its effects.
- In the Organisational Strategies group, theories of organisation and innovation are predominant.

- In the Quality group, policy sciences and the technical disciplines are predominant.

Our in-depth multidisciplinary research on housing contributes to the theoretical and applied scientific debate at conferences and in scientific journals on housing, building, energy, policy sciences and organisation.

2.1.4 Societal relevance

Housing is of crucial importance to the economy, to the ecological footprint and to the well-being of households. Since the start of the global financial crisis, the role of the housing market has shifted in many countries, whereby housing is no longer one of the main drivers of the economy. On the contrary, investment in housing and the improvement of housing have stagnated. At the same time, international treaties and regulations at the European and national level set very high targets for the reduction of CO_2 emissions, also applying to the housing stock. The building stock in the European Union accounts for about 40 per cent of all EU energy consumption. In recent years, domestic energy consumption has increased dramatically in both relative and absolute terms due to the growing number of households and the consequent higher utilisation of power for appliances, room heating and hot water.

Moreover, housing used to play an important role in social policy, and the provision of affordable dwellings was called the wobbly pillar of the welfare state. This welfare function is now questioned; the increasing amount of wealth concentrated in owner-occupied dwellings is considered an important source of well-being for individual households. A complete reversal has occurred in the relation between housing and welfare. There is insecurity in the market: despite the need for housing, parties are reluctant to invest in it. Investors need insight into future demand, the development of house prices and the expected rate of return on their investment in order to put together a sustainable portfolio strategy.

Housing has a new role to play in society, but we do not know enough about what it may entail. More knowledge about new technologies, housing preferences, house prices, management strategies and policy instruments is necessary in order to achieve a sustainable fit between demand and supply.

2.1.5 Internal and external collaboration

The Housing research groups cooperate with many other groups, such as that of Urban and Regional Governance. There is a clear link and a solid record of cooperation between the subgroups Market Dynamics and Land Policy as well as between the subgroups Neighbourhoods and Governance.

Moreover, the Housing group is active in international scientific networks such as the International Council for Building (CIB) and the European Network for Housing Research (ENHR). The group also has ties with the Centre for Comparative Housing Research of De Montfort University in Leicester (UK), the Australian Housing and Urban Research Institute (AHURI), the Rural Institute in Seoul, Reading University (UK), University of Glasgow, University of Birmingham, the Cambridge Centre for Housing and Planning Research (CCHPR), Uppsala University, the University of Aalborg, Hong Kong Polytechnic University, University of York, University of Leuven, University of Eindhoven, Nyenrode, and Wageningen University. These ties entail exchanging knowledge, providing facilities for visiting researchers and exploring possibilities for joint projects.

With an eye to the future, the Housing group is cultivating supportive networks and continuing its involvement in proposals for the European Commission. And the group keeps building on a long tradition of working with professional stakeholders in various organisations: Platform31, the European Foundation for Living (EFL), Aedes Steunpunt Wonen, Consortium of European Building Control and the Expertise Centre on Housing Value, Building Future (EOS), COHERENO (Collaboration for Housing nearly zero-Energy RENOvation), and the EPISCOPE consortium for the optimisation of the refurbishment process.

2.1.6 Relations with education

The research group has a long history of teaching in Bachelor's and Master's courses within the Faculty of Architecture, where it takes part in educational activities for Real Estate and Housing. The group also contributes to Bachelor's and Master's education in the domain of Building and Spatial Development at the Faculty of Technology, Policy & Management. Moreover, the research group is keen to implement a minor on sustainable housing strategies for students from both the Faculty of Architecture and the Faculty of Technology, Policy & Management.

Members of the group also teach at the Faculty of Mechanical Engineering of TU Delft, Utrecht University of Applied Sciences, The Hague University of Applied Sciences, and the Amsterdam School of Real Estate. Finally, the group gives courses to practitioners on recent developments in the housing market, housing portfolio management and risks associated with the owner-occupied market.

2.2 Market Dynamics: Demand, supply and price

2.2.1 Introduction

The Market Dynamics group pursues its objective of unravelling how the housing market functions by focussing on the factors of demand, supply and price with special attention to their interdependence. Research on the demand side concerns identifying, quantifying and explaining consumer preferences and choices. On the supply side, the focus is mainly on the structure and outcomes of the housing market and housing production. Knowledge about the way the housing market functions is applied to develop house price and housing market models. The research uses both quantitative and qualitative methods and draws upon the disciplines of psychology, economy and geography to understand the housing system. The interplay between governance and housing markets is one of the central themes of this research programme.

For decades, housing production in the Netherlands, as well as in most other West European countries, was supply-driven. Alleviating large quantitative housing shortages was the primary policy objective. During the 1990s, a period of economic prosperity, housing policy shifted toward a market orientation and pursued a higher sustainable housing quality. By now, at least in parts of several European housing markets, the quantitative housing shortages have become much smaller or even disappeared, so qualitative aspects of housing demand have come to the fore, both in the housing market and in the house-building market. To address these qualitative aspects, knowledge about the housing preferences and choices of housing consumers in relation to the actual housing market behaviour is necessary. The impact of the current economic recession on the housing market and housing production makes it even more important to acquire such knowledge. This shift from quantitative to qualitative housing demand calls for new instruments that put the potential user rather than the dwelling at

the centre of analysis. For instance, measuring consumers' attitudes towards sustainable housing is one of the new topics of research on housing demand and residential satisfaction.

One of the consequences of the financial and economic crisis, and of the government responses to it, may well be a structural change in the character of housing markets. If so, the crisis will also have an impact on the development of house prices, the structure of the house-building market and the position of actors in that market. It is important to trace these changes and their consequences to understand the development of housing market outcomes. Identifying structural changes requires qualitative research, taking into account the influence that different tenures, government policies and financial institutions exert on the housing market. The results of this qualitative research can be used as input for refining quantitative housing and house price models.

These considerations lead to the following research questions for the Housing Market group:

1. How can the development of housing preferences and choices be identified, measured, quantified and explained?
2. How do the housing and house-building markets operate, and how can price and other developments on the housing market be explained?

Key topics

1. Housing Preference, Housing Choice and Housing Satisfaction

The overall objective of the Housing Market group is to develop reliable and valid measurements of housing preferences, housing choice and housing satisfaction, and to investigate their mutual relationships. Current knowledge on housing preferences (see, e.g., Jansen et al. 2011) will be elaborated, and associated measurement procedures will be improved. For a better understanding of households' preferences and choices, the group will develop a new approach to measuring housing preferences that is in line with previous work by Coolen (2008). This approach is based on Gibson's theory of affordances (Gibson 1977), which provides a conceptual framework for understanding the relationship between dwellings and inhabitants in terms of the objectives and activities of the latter. Based on this framework, a methodology and measurement procedure for affordance-based housing preferences will be developed.

Insufficient isolation causes high energy consumption.

In previous research, the group has demonstrated that housing preference and choice have a substantial impact on residential satisfaction, which is an important component of individual well-being and quality of life. Jansen (2012, 2013) identified a number of psychological

mechanisms that link housing preference and choice to residential satisfaction. For example, people in a low-quality housing situation can express a relatively high level of residential satisfaction because they have lowered their aspirations ('I don't need much'). It is important to realise that such a mechanism might lead to a positive bias in residential satisfaction. In addition, the preferred level of housing quality tends to change as prosperity increases. For example, in the past the presence of a full bathroom was a luxury, but in the future one full bathroom might not be enough to satisfy residents. It is therefore important to determine which dwelling aspects are becoming important predictors of residential satisfaction. These topics will be explored in future research.

The third research direction of the Housing Market group involves determining the preferences for and the satisfaction with sustainable housing. To save energy and protect the environment, national and international governance bodies have assigned a high priority to sustainable housing. Energy costs make up a substantial and increasing part of the total housing expenses of households, which should make consumers more eager to live in sustainable houses. However, research has shown that the large gap between the high initial investment and the moderate decrease in energy costs in the short run makes consumers hesitant to opt for sustainable houses. Research on the relation between preferences for sustainability and actually opting for sustainable housing must therefore be intensified (Guerra Santin & Itard 2010). The issue of user demand relates directly to the perceptions of users, their acceptance and their residential satisfaction (Mlecnik et al. 2012). Post-occupancy evaluation of sustainable buildings (including residential satisfaction) and ex ante experiments are the two main methods the group will use to develop new housing concepts that suit these preferences.

2. The housing and house-building markets and house price developments

The overall objective is to understand the actual workings of the housing market and to use this knowledge when developing housing and house price models. Although neoclassical economic theory is a valid point of departure, the housing and house-building markets do not meet all the conditions of an economically efficient market (Barr 1998; Priemus 1978). Thus, in order to understand the actual workings of the housing market, it is important to look in detail at how the housing and house-building markets operate. Here, the relevant questions are:

- What is the exact influence that economic and demographic changes have on the balance between supply and demand and the resulting price changes in the housing market, and how does the house-building market react? (Van der Heijden et al. 2004; Boelhouwer et al. 2006)
- How are the housing market and housing production affected by changes in the policy framework within which they operate? And how do the various authorities, private-sector actors and housing consumers react to changes in the housing market?
- What strategic decisions underlie the behaviour of the actors involved in the housing and house-building market, in light of what is known about the institutional framework of the housing market and the roles of the actors involved? (Healy 1992; Healy & Barret 1990)

In the coming years, the group will investigate the effects of the current financial and economic recession, and of government responses to it, on the housing market and the house-building market, with special attention to the ensuing changes in the housing market and therefore in the housing system. International comparative research on the structural effects of the economic crisis on the housing and house-building markets will be carried out. It is expected to yield insight into the relationship between the structure of housing markets and the effects of economic crises (Van der Heijden et al. 2011).

Knowledge about the functioning of the housing market and housing supply can be used to develop house price models. In the 1990s, the OTB was the first research group in the Netherlands to develop a model to explain and predict price developments in the owner-occupied housing market. This model was revised in 2001 and has since been applied extensively (Boelhouwer et al. 2004, De Vries 2010). In recent years there have been new developments in econometric modelling techniques, taking into account differences between a long-term trend and short-term fluctuations (Maddala & Kim 2003) and structural changes in the housing market.

A potential structural trend in the Dutch housing market may be inferred from the expectation that regional variations in shrinkage and growth will increase in the coming few years, leading to differences in house price changes. This calls for a regional disaggregation of the house price model. Another possible structural change may come from a shift towards a more market-oriented rent policy in the near future. This policy revision would provide an opportunity to model rent developments and to study the relation between house price developments and rent developments.

The economic crisis has led to substantial price decreases in the Dutch owner-occupied sector for the first time in 25 years. This has put the risks associated with homeownership on the agenda again, both in the Netherlands and elsewhere. An important research question is how the payment risk and equity risk connected to homeownership can be measured and analysed.

2.3 Governance: Affordability, welfare states, institutions

Introduction

The Housing Governance group investigates the institutions that constitute the housing market and the governance that influences this market in order to achieve adequate, affordable and secure housing. Housing institutions are housing organisations and laws (formal institutions), as well as norms and values (informal institutions), as defined by the Nobel prize-winners North and Williamson (2000). The research of the Housing Governance group is therefore focused not only on government policies but also, for example, on the role of networks of actors and their values and attitudes. Some of the key research questions are the following: How do housing policies and institutions change?; How does such change impact economic growth and welfare?; and How can housing in different countries be compared?

In many countries, housing has recently undergone a major shift from government intervention towards more market influence. The notions of the market, a level playing field, competition and efficiency became catchwords in the housing debate. However, the difficulty of applying these key concepts to the field of housing is underexposed. For instance, the contractibility of housing quality is problematic, so non-profit housing may in fact be more efficient than for-profit housing (Glaeser & Shleifer 1998). The concept of competition is underresearched in the context of housing. We need to investigate how to measure the success of competition in affordable housing provision, a field characterised by strong government intervention. Another key issue is how to deal with organisations that create social value in a market environment, such as social enterprises. For instance, how does the level playing field that is advocated by the European Union relate to the 'social markets' in Scandinavia and continental Europe (Sharpf 2009)? By addressing such questions, the Housing Governance group contributes to the on-going debate on social innovations and social enterprises. It tackles a fundamental dilemma: the extent to which being efficient can be combined with creating social value and how this can be done.

Housing supply in different European countries.

Since the early 1990s, the group has shown a strong track record in comparative housing research. Over the years, its research approach has developed into what is called a 'middle range approach' (Hantrais 1999). That is, the group acknowledges the differences between countries but also explores methods that make proper comparisons possible. Its middle range approach supports the transferability of policies and enables countries to learn from each other. This is important, since the challenges faced by housing policy makers are huge. How can they accommodate the strong urbanisation and the need for affordable and secure housing in the emerging economies of Southeast Asia and Latin America? How can they develop policies for a competitive and inclusive Europe, while taking into account the differences between European countries?

On the one hand, the group analyses the effects that housing and housing governance have on economic growth and welfare. On the other hand, the group studies housing governance as a means to provide adequate, affordable and secure housing in a period of financial austerity. Even though the results from the latter perspective can feed into those from the former, these two focal points are put forward as separate research questions:

- What shape should housing governance take in order to achieve adequate, affordable and secure housing?
- How do housing and housing governance impact welfare and the economy?

Key topics

1. Housing governance for sufficient, affordable and secure housing

'What is affordable housing and how can it be achieved?' This has been the group's key research question since its inception. Through the years, we have elaborated different definitions of affordability. Moreover, we have adopted the concept of 'user cost' to compare the costs for homeowners and tenants, and we have reflected on the concept of tenure neutrality (Haffner & Heylen 2011).

Furthermore, this list of typical policy ingredients, which serve to promote affordable and accessible housing, has been extended by exploring the field of welfare economics (Barr 1998) and theories on non-profit housing (Glaeser & Shleifer 1998). The central question was, 'What exactly is the aim of policy, and in what ways can that aim be achieved?' The envisioned outcome was a theoretical framework to evaluate different policy instruments that are intended to safeguard the affordability and accessibility of housing while also taking into account the risks of homeownership. Research was conducted on policy tools ranging from supply instruments (intermediate housing, subsidies and supplier loan guarantees) to subject subsidies (housing allowances and mortgage guarantees) (Gruis et al. 2005; Haffner & Boelhouwer 2006).

Parallel to the discussion on subsidies, there was a debate on the role of affordable housing organisations. The group studied the relation between social and commercial rental housing. In particular, it considered the implications of a level playing field for these sectors and the role of social housing as a safety net for the most vulnerable households. The inquiry posed questions such as the following: Is it possible to make these organisations more efficient and self-sufficient? What kind of governance arrangements can be used to safeguard the efficiency, effectiveness and accountability of affordable housing providers? What role can be played by the state, market parties, third-sector organisations and residents? (Van Bortel & Elsinga 2007; Van der Heijden 2013). The last-mentioned question pertains not only to social rental housing but also to low-income homeownership in condominiums. The governance of affordable owner-occupied housing was also a relevant research topic.

Another topic the group has investigated is the extent to which governments should protect tenants from the market power of landlords, and how they could do so. Prior research has shown that a well-functioning rental market will only exist if the interests of tenants and those of landlords are somewhat in balance (Haffner et al. 2008). Therefore the question of how to achieve adequate and affordable housing also has a legal dimension: both landlord and tenant need security and clarity about their position. The research group is currently participating in the European TENLAW project, which is comparing tenancy laws all over Europe.

This new research programme will meet a challenge when tackling the first research question (What shape should housing governance take in order to achieve adequate, affordable and secure housing?). The challenge is to contribute to the current housing debate about the role of new and incumbent actors and co-ordination mechanisms in the creation of social innovations in a manner that could increase the affordability, accessibility and security of housing and housing-related services such as energy and commuting. The housing governance group will infuse today's housing debate with state-of-the-art theoretical insights and empirical knowledge on social entrepreneurship and network forms of collaboration between actors in the housing sector. It will thereby contribute to a better understanding of how housing systems produce social value.

2. Impact of housing and housing governance on welfare and the economy

Housing and economic development are closely related and intertwined. The capital intensity of the housing market has a huge effect on macro-economic outcomes. Boom cycles on the real estate market can boost economic growth, but a housing market crisis can severely harm the economy. Moreover, housing expenses have a great impact on the purchasing power of households and thus also on economic development. Finally, housing allows individual households to build assets for extra consumption during their lifecycle, for example to afford health and care expenditures in old age. In this regard, housing policy can buttress a sustainable pension policy and reduce the need for public pensions (Groves et al. 2007;

Toussaint 2011). During the global financial crisis, the links between housing, welfare and the economy have changed, prompting some timely questions. Can a mix of housing policy instruments be designed that is effective and efficient in times of financial austerity? What could be the role of housing wealth and how can the risks of homeownership be dealt with? How will these risks and the associated welfare of households evolve if governments encourage people to become homeowners and strive for asset-based welfare instead of diverting investments to the rental sector? Such questions are currently being examined by the research group, for example within the framework of projects for the European Commission (Doling & Elsinga 2012).

One challenge implicit in the second research question (How do housing and housing governance impact welfare and the economy?) is the obligation to enrich the current debate on housing, markets, welfare, pensions and economic development with theoretical insights and empirical information from different countries. In doing so, we apply a middle range approach. We recognise the substantial differences between the various European welfare and housing systems (Hoekstra 2010). And we acknowledge that the resulting impact of policies related to the global financial crisis differs between countries. This differentiation implies that policy transfer will only be successful if the aspect to be transferred is contextualised (i.e., adapted to a specific context).

2.4 Organisational strategies: Asset management, partnering relationships, corporate governance

Introduction

The adaptation of housing to keep up with societal needs – reflecting, for example, changing household size, the need for energy efficiency as well as an ageing population – largely entails redevelopment of the existing stock. Given the higher levels of homeownership as well as the low turnover rates in the rented sector in many regions, redevelopment strategies will have to accommodate a variety of individual household preferences and means. Declining state support, a stronger reliance on private finance as well as the adoption of 'new public management' precepts and related concepts leads social housing providers to adopt more business-like principles (e.g., Heino et al. 2007). Moreover, public authorities and landlords expect more from contractors in housing development, refurbishment and maintenance. The public sector has introduced supply-chain partnering requiring contractors to take a leading role in the (re)development processes. They are expected to comply with innovative refurbishment concepts and take over tasks formerly conducted by the principals, such as budgeting, participation with households and monitoring (e.g., Bygballe et al. 2010). Additionally, many governments expect a more active participation of individual or collective households in providing and managing housing. This is part of a wider trend towards increased self-organisation, (re)activation of civil society and retrenchment of the welfare state. Thus, policy reforms and changing socio-economic circumstances have significant consequences for the organisational strategies employed by landlords, contractors and households in housing provision and management. The aim of this sub-programme is to contribute to the development of organisational strategies. This can be done in two ways: by evaluating the innovative approaches; and by employing and testing general theories and adapting these – ranging from management, technology and organisational studies – to the specific area of management and redevelopment of the housing stock.

The topic of organisational strategies in housing provision has drawn increasing interest from academic researchers. It has been a key theme within the Housing research programme for the past two decades. Several theories have been formulated on the management, mainte-

nance and procurement strategies of professional housing providers (e.g., Nieboer 2009; van Mossel 2008). Despite the academic input, these studies have not addressed the broader issues that arise from the changing political, regulatory, demographic and economic context. Financial pressures, shifting demands and societal developments compel housing providers to adapt their visions and strategies (e.g., Gruis & Nieboer 2004). Furthermore, due to a general increase in owner-occupation, organisations increasingly interact with individual homeowners and homeowners' associations (e.g., Gruis et al. 2009). This implies a much more individualised approach to housing refurbishment and maintenance, one that takes into account the preferences and means of individual households. Many of the theories that have been formulated take a rational, systematic, top-down approach to strategy development and implementation by professional housing providers. And these have proved to fit poorly with the practice (Nieboer 2009; van Overmeeren & Gruis 2012). Likewise, contractors in housing refurbishment and maintenance also have to adapt their organisation and strategies to the changing context. On the one hand, they need to turn themselves into efficient and effective supply chain partners in order to meet the shifting demands of professional housing providers, for example by adopting full-service and performance-based contracting strategies. On the other hand, they need to work out refurbishment approaches that allow a fit with varying individual tenants' and homeowners' preferences and means. Although many innovative approaches to management and procurement strategies have been advocated and tried out in pilot projects, the rate of diffusion is low. In fact, scientific knowledge on the performance and advantages and disadvantages of various approaches is scarce. In that light, the main research questions that are addressed within this sub-programme are the following:

- How do or can public and private housing providers, households and contractors adapt themselves and their assets to changes in their context and demand for housing and related services to increase the socioeconomic and environmental sustainability of the housing stock?
- How do or can renovation and maintenance processes become innovated to improve and maintain housing in a more effective, efficient and sustainable manner?

Key topics

1. Strategies of social housing providers

Housing policy in many European countries, reflecting a wider neoliberal tendency, has shifted in recent decades from a reliance on government control towards the reinforcement of market principles (e.g., Boelhouwer 1999; Ghekière 2007). For many social housing providers, this shift has meant both greater freedom and more responsibility in performing their social activities at the local level, as well as a challenge to achieve their social objectives with less public resources (e.g., Gruis & Nieboer 2004).

Furthermore, certain cultural and societal developments are having an impact on the evolution of social housing providers. Overall, European society has changed greatly in the last 20 years. Families are now smaller, life expectancy is higher, divorce rates have risen steeply and there is a trend towards continuing immigration (European Communities 2004). The ageing of the population poses a particular challenge for social housing providers, as their properties are mostly occupied by people who have relatively restricted financial means to secure the services and alterations they need for their homes.

Renovation and maintenance require supply chain partnering.

Furthermore, despite the general rise in affluence, persistent levels of unemployment are threatening to increase inequality, polarisation, spatial segregation and the concentration of low-income households in the social rented sector (e.g., Van der Heijden 2002). These contextual developments have several effects on the strategies of social housing providers. For example, prior to the financial crisis, Dutch housing associations had broadened their scope of market and social activities but are now consolidating and reducing their range of activities, all in response to economic, political, regulatory and ideological changes (e.g., Nieboer & Gruis 2013). Across Europe, social housing providers are adapting their housing stock to meet the changing demand as well as to increase its sustainability (including energy efficiency), though with varying degrees of effort and often with limited financial means (e.g., Heino et al. 2007). The sustainable transformation of the housing stock has become even more difficult. Change in the economic and regulatory environments forms an obstacle, but so does the general reduction in new housing construction by limiting the possibilities for large-scale demolition and refurbishment programmes. In response, housing organisations are seeking new ways of combining small-scale renovation with adequate social and physical management programmes to keep the housing stock and neighbourhoods in acceptable condition. They are also looking for new organisational and financial models to facilitate social and physical management, involving tenants, homeowners and prospective homeowners, contractors, and other social and market actors and networks in innovative ways. These shifting strategies also require changes within their organisations in order to be able to facilitate those activities. Therefore, many social housing providers are reconsidering the size and nature of their organisation. They are deciding which activities should be performed within the organisation and which should be conducted in partnerships or coalitions, perhaps outsourced or abandoned. Within the key topic 'strategies of social housing providers', the interplay between the changing organisation and asset management strategies is studied. The group thereby addresses the following research questions:

- Which asset management strategies have been or can be adopted by social housing providers to increase the socioeconomic and environmental sustainability of the provision of housing services in a changing societal context?
- Which organisational strategies have been or can be adopted by social housing providers to facilitate asset management strategies that increase the sustainability of the provision of housing services?

2. Innovation in housing renovation and maintenance

Given the important role of adequate technical management in achieving the more general housing objectives, housing providers, housing owners and housing contractors must develop a strategic vision for procuring and contracting maintenance services. They need to de-

termine which maintenance services are crucial to the housing objectives, which forms of procurement are appropriate, and which role various actors play in the supply chain of maintenance services (e.g., Straub 2001; van Mossel 2008).

As shown by several studies, traditional building and maintenance processes do not always meet contemporary quality standards while their failure costs and transaction costs are high. Further innovation in building and maintenance processes and related forms of partnering and co-operation is necessary in order to satisfy the need for a more sustainable housing stock and more efficient housing management (e.g., van Hal & van Bueren 2011). Supply chain partnering requires professionalisation not only among housing providers but also among contractors. New approaches are needed: performance-based contracting in housing renovation and maintenance as well as full-service packages. Once such approaches are developed, landlords will be able to focus on their role as a principal and become better partners for non-professional principals such as homeowners' associations.

Furthermore, as noted above, renovation strategies are expected to coincide with the preferences and means of individual households. Therefore, process innovation must go hand in hand with the development of flexibility, allowing for step-by-step improvement and dwelling-by-dwelling refurbishment. Partnering between housing providers, homeowners and contractors is seen as a promising way to lower costs, improve quality, accelerate renovation, and fulfil contemporary and future quality requirements. Mlecnik (2013) showed that the adoption of highly-efficient housing will increase as enterprises collaborate with market players and innovation intermediaries. Professional housing providers could combine similar challenging demands for renovation in packages for joint procurement strategies, thereby boosting the market for innovative approaches. Contractors, on the other hand, could join forces with other contractors, service and product providers that have complementary skills. Together, they can develop business schemes and approaches for housing renovation that respond to the challenges mentioned above.

These considerations lead to the following research questions, which are addressed by several projects within the key topic 'innovation in housing renovation and maintenance processes':

- Which procurement strategies contribute to the development and innovation of renovation and maintenance concepts?
- Which innovations in partnering approaches of housing providers, housing owners and housing contractors can satisfy the need for lower costs, higher quality and acceleration of sustainable housing renovation and maintenance by fulfilling current and future quality requirements?
- Which factors stimulate or impede the diffusion of innovation in housing renovation and maintenance processes?

2.5 Quality: Energy-efficient housing, sustainable and healthy housing, building regulations

Introduction

The quality of the housing stock is of major importance, as it affects the life of the occupants, the ecological footprint of urban areas and the economic viability of assets. This quality has to be maintained and improved considerably in the coming decades in order to meet the increasing demands of the occupants, reduce the ecological burden and contribute to energy savings and CO_2 reduction targets.

The building stock in the European Union accounts for about 40 per cent of the total energy

consumption of the EU, the residential stock for 30 per cent. The residential sector is generally considered to have the highest potential for energy efficiency measures at the lowest cost. Energy-saving in the built environment has been highly recommended by the European Union, which has even opted for a communal approach. It requires the Member States to formulate regulations and action programmes to realise high energy-efficiency goals in the housing sector in order to achieve an energy-neutral situation by 2050. Some 75 per cent of the housing stock of 2050 already exists today. This means that an enormous renovation programme has to be carried out in the coming decades to reduce the energy demand for space heating and cooling and to integrate renewable energy techniques so they will cover the remaining energy demand. Calculations show that renovation rates of three per cent per year on a level of nearly zero-energy buildings (NZEB) are needed. This challenge will require much effort, and many scientific and practical questions remain to be solved.

The Housing Quality sub-programme focuses on two questions:

1. How can energy efficiency be achieved in a sustainable way while assuring a healthy indoor climate in housing?
2. What are effective and efficient policies, regulations and stimulation and enforcement programmes and procedures to assure that housing quality goals are met, and to realise an energy-neutral housing stock by 2050?

Key topics

1. Assessment of energy efficiency, environmental impact and indoor air quality

Energy-efficiency goals in housing are traditionally monitored with indicators like insulation degree, type of heating equipment, energy index or energy labels. Such indicators have the advantage of being cost-effective and relatively easy to use. However, they do not measure the actual energy consumption directly. Questions have recently been raised concerning whether they are suitable for monitoring actual energy efficiency (Guerra Santin 2010; Majcen, Itard & Visscher 2013). Large discrepancies were shown to exist between the consumption predicted by the indicator (energy index, energy label) and the actual amount of energy consumption. Similar results were obtained in other countries (e.g., Hens et al. 2010).

More generally, the assessment of energy efficiency, environmental impact or indoor climate quality in houses is a challenging task. One reason is that these parameters are interrelated (e.g., energy-saving measures may affect the indoor climate and thereby the health of the occupants; conversely, indoor climate preferences of occupants will affect energy efficiency and environmental impact). Another reason is that they are sensitive to other parameters (physical, economic and occupancy/behavioural parameters) that influence their value in a non-linear way. Furthermore, traditional assessment methods are suitable for a single house or group of houses but cannot be applied directly to the large samples needed to study the housing stock.

The research on this key topic is therefore aimed at developing assessment methods for energy efficiency, environmental impacts and indoor climate quality that are suitable to support policies and regulations relating to the housing stock. This is done by combining statistical methods using large-scale surveys and measurement campaigns with smaller-scale studies where in-depth analysis can be conducted. The analysis of data on the current situation helps us understand the mutual relationships between energy efficiency, indoor climate and environmental impacts and to gain insight into their relation with behaviour and comfort preferences.

It also allows us to construct better prediction models and improve the regulatory standards.

The group has built up expertise in assessment methods through a large number of private, national and European Union funded research projects that led to PhD theses and many publications. For instance, Blom, Itard and Meijer (2010, 2011) showed the need to consider not only the operational energy consumption but also the energy embodied in materials and components. Majcen and Meijer (2012) recently showed that, especially for nearly zero-energy buildings and passive houses, the embodied energy is important and should be taken into account. The assessment should inquire whether the environmental impact of buildings is reduced more by passive measures (like insulation) or by using renewable energy (like PV cells), a field that will be investigated further. In addition, the environmental impact of electricity consumption by appliances and lighting in Dutch dwellings was shown to be higher than the impact of heating energy. This raises the question of whether the focus of building and housing stock policies should be on measures like insulation or on the transition to renewable energy.

Recent research by the group shows that regulations on energy performance may not lead to the expected savings in heating energy. Guerra Santin (2010) found a very weak correlation between the energy performance regulations for newly built houses and actual energy use, as well as a possible impact of occupant behaviour on this. Majcen et al. (2013) investigated the energy consumption of nearly 200,000 dwellings in the Netherlands. They found that the energy consumption of houses with lower label categories (E to G) was strongly overestimated (by as much as 100%) with models used to calculate the label, whereas it was underestimated for higher labels (A and B). The implication is a serious overestimation of possible energy savings when implementing renovation measures. They also showed that characteristics of buildings and equipment are related to occupant behaviour. For instance, when people have a programmable thermostat, their heating runs for more hours; and people's temperature preferences are higher in well-insulated dwellings. In the coming years, our research will determine comfort preferences, occupancy patterns, and the actual performances of heating and ventilating equipment. The aim is to develop solutions for robust energy-saving strategies (robust meaning less vulnerable to variations in behaviour and building mistakes). The EU SuslabNWE project and the Dutch MONICAIR project will contribute insights to that development effort. The research results will also be shared in the UserTEC project, which is being carried out in collaboration with universities in several EU countries.

2. Evaluation of policy instruments and enforcement procedures

The research group is addressing another important question, namely whether policy instruments – regulations, financial incentives or information campaigns – are effective and efficient enough to guarantee basic qualities and improve the energy performance of the housing stock. The effect of instruments such as the general building regulations and the more specific energy performance regulations is being studied. The group is evaluating various policy instruments used by national or local governments to stimulate the quality improvement of the existing stock. Specific instruments are being studied within the broader context of building regulations and enforcement systems by conducting international comparative research.

Looking into regulatory systems from a more abstract angle, it appears that the dominant trend has been to streamline the regulations and the building permit procedures (e.g., Costa Branco et al. 2011). This reflects the fact that national building regulatory systems are increasingly at the centre of attention in policy evaluation as well as academic research. In almost every EU country, building regulations and their enforcement are being discussed both in and outside parliament. The discussion revolves around potential conflicts between the

goals of the regulations and the restrictions and burdens they entail for housing consumers and other actors in the construction process. The questions raised and the answers sought are fundamental and are captured by the main research questions on this topic in this sub-programme.

Despite the growing number of internationally oriented research projects in this field, there is still no coherent tradition of international comparative research into building regulatory systems. In recent and on-going European comparative projects, we embedded (or are embedding) our comparative studies within the framework of Europeanisation, which is a burgeoning field in the regulatory sciences. The EU is able to influence the regulatory systems of Member States, and this influence can be independent of all other international external developments (e.g., deregulation, convergence or harmonisation that may affect national policies; see Bulmer & Radaelli 2004).

Energy-efficiency goals are set for all EU members.

With respect to the technical requirements within the building regulations, progress has been made in developing a theoretical framework for analysing the content and formulation of the requirements (e.g., May et al. 2003). Work on developing a performance systems model for technical requirements yielded a useful tool for comparing the technical requirements in various countries. In the case of energy and sustainability regulations, we are carrying out an in-depth analysis of the requirements (in close co-operation with the sub-programme on Assessment of energy efficiency, environmental impact and indoor air quality). International comparative research in this field is carried out in collaboration with the Consortium of European Building Control (CEBC), the Inter-Jurisdiction Regulatory Collaboration Committee (IRCC) and the CIB task group 79 (Building Regulations in the Face of Climate Change).

Within the realm of building quality and policy instruments, we focus on instruments that are supposed to improve the energy performance of the existing housing stock (e.g., Meijer, Itard & Sunikka 2009). The EU and its Member States have formulated many policies in an attempt to reach their energy-efficiency goals through renovation work. These targets are ambitious; to achieve them, the amount and extent of renovation work must be increased. Research by Meijer et al. (2012) shows that neither the actual rate nor the extent of renovations comes close to achieving the current targets. General policy instruments – such as the Energy Performance Certificate (EPC), covenants, economic incentives and information tools – are used to derive energy savings from this stock. However, research in this field, as reported by Murphy et al. (2012) for the privately owned housing stock in the Netherlands, demonstrates the weak impact of these instruments and a lack of consistent evaluation. The findings show that current instruments are poorly equipped and thus unlikely to result in

long-term energy savings in existing dwellings. To realise energy savings in the existing housing stock that come close to the estimated potential and the goals set by governments is a complex task. Despite these goals and the instruments implemented by governments, comprehensive strategies, effective instruments and transparent results are lacking (Hamilton et al. 2010). It will not suffice to implement one or two regulatory instruments to tackle this problem: combinations of instruments are required to deal with the complexities of many policy issues in this field (Howlett 2011).

The European EPISCOPE project will offer insight into the progress that is being made by the implementation of energy-efficiency policies and programmes and the rates and nature of energy renovations in the housing stock in 17 EU countries.

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3 Urban and Regional Studies (URS)

3.1 Introduction to the programme

3.1.1 Mission and research area

Urban and Regional Studies is concerned with the interrelationships between the every-day social and spatial patterns, growing complexities and governance of neighbourhoods, cities and regions.

The URS programme has four sub-programmes:

- *Governance of Land Development* is about the interaction between planning, property rights and property markets, the governance of the relationship between private interests of landowners and common societal goals.
- *Territorial Governance* is concerned with the relationships between the polity and politics of territorial development and critical issues related to the competitiveness of cities and regions, sustainable development and resilience.
- *Urban and Neighbourhood Change* investigates neighbourhoods and cities as changing social sites and as sites of governance and civic action, including the effects of neighbourhoods on residents and how residents affect neighbourhood stratification.
- *Urban Systems and Transport* studies how the built environment interacts with spatial and transport behaviour, how this influences urban performance, and how these interactions can contribute to more competitive, sustainable and liveable cities.

By structuring the programme in four focused sub-programmes, each with the mass needed to make a difference, opportunities arise to be at the forefront of scientific development.

3.1.2 Update and merger of previous programmes

Urban and Regional Studies is based on three previous programmes:

Neighbourhood Change and Housing – Formerly called Urban Renewal and Housing in the period 2003-2006, this programme was concerned with the ways in which residential districts are ordered, organized and lived as everyday realities in a changing urban world. It has developed into the present sub-programme *Urban and Neighbourhood Change.*

Urban and Regional Development dealt with the interrelationships between the ever-growing complexity of urban systems and the extent to which the development of these systems can be influenced through policies and governance. Its two research themes have been recast to form two separate sub-programmes. The first theme covered spatial development. Research on this theme was focused on how the functioning of the spatial system affects the basic aims of spatial policy, social well-being, economic competitiveness and environmental sustainability. This first theme has been reconceptualised to form the new sub-programme *Urban Systems and Transport*. The second theme, spatial governance, covered the evolution of spatial planning systems and practice, the spatial implications of European policies and comparative planning methods. It has been developed into the new sub-programme of *Territorial Governance.*

The *Governance of Geoinformation and Land Development* – which sought to improve the knowledge available for effective land management – has been split up. Its research was divided between the Urban and Regional Studies programme and the Geoinformation Technology and Governance programme. All of the research on the former theme of Land Development and part of the research on the former theme of Land Tenure and Property Rights have been consolidated in the sub-programme *Land Development*.

All three previous research programmes had been given a positive assessment. The sub-programmes form solid building blocks for the new research programme Urban and Regional Studies.

3.1.3 Scientific relevance

Urban and Regional Studies is a thriving interdisciplinary field. According to the listing of Thomson Scientific, 37 journals published 1621 articles in 2011 in this sub-category of Urban Studies. The list includes the partly overlapping disciplines of Planning and Development (54 journals, 2359 articles), Environmental Studies (89 journals, 5115 articles) and Transportation (24 journals, 1505 articles), which are also addressed by this programme. Apart from these interdisciplinary sub-categories, it also addresses mono-disciplinary sub-categories such as Geography or Sociology. Yet only part of the lively scientific debate in this field is captured in journals covered by Thomson Scientific (or ISI in the past). Traditionally, many relevant journals have not been covered by its web of knowledge database. There are, of course, other means to publish in the field of Urban and Regional Studies, such as writing contributions to books.

3.1.4 Societal relevance

Issues such as sustainable urban and regional development and the idea of resilience in this context currently have a high profile. This interest is indicative of the significant societal importance that urban and regional studies have attained. The diversity of approaches to these issues testifies to the high societal relevance of developing scholarly research in this field. Resilience thinking, for example, is about how "… scholars, practitioners, and policymakers may integrate a perspective that presupposes uncertainty, heterogeneity, and collective entanglement." (Taşan-Kok et al., 2013, 45). The embedding of the programme in the TU Delft entails that "it seeks to answer utility-driven questions in a fundamental way" (TU Delft, 2012, Roadmap 2020, p. 47). So by default, most of our research is driven by societal relevance. A programme seeking greater understanding of competitive, sustainable and liveable cities and regions, territories and neighbourhoods is highly relevant, especially as it addresses these aspects in relation to governance and planning. The results of its research provide insights into the interactions between authorities and market players but also between institutions and people in a day-to-day living environment.

3.1.5 Internal and external collaboration

The programme contributes to a variety of networks and collaborations. Some of the international networks of researchers in which the group co-operates are the following:

- Association of European Schools of Planning (AESOP)
- European Network of Housing Research (ENHR)
- International Academic Association on Planning Law and Property Rights (PLPR)
- Regional Studies Association (RSA)
- World Society for Transport and Land Use Research (WSTLUR)
- Regional Science Association (ERSA/RSAI)

- Network on European Communications and Transport Activities Research (NECTAR)

The research group also takes part in collaborations facilitated by European institutions. For instance, it contributes to the Seventh Framework Programme and it intends to use such networks for Horizon 2020.

The Urban and Regional Studies programme fits well into the Netherlands Graduate School for Urban and Regional Research (NETHUR). It also has some disciplinary ties with other graduate schools, for instance Ius Commune in relation to law and TRAIL in relation to transport.

Regeneration of rundown industrial areas.

The group collaborates with other OTB research programmes. Its ties with Housing in a Changing Society are the most obvious, as housing is of great importance in urban areas and regions. But it also has ties with Geoinformation Technology and Governance. The collaboration involves the analysis of developments using geographical information systems but also concerns the governance of geographical information in relation to urban and regional governance. The URS group has close ties with other departments in the Faculty of Architecture and the Built Environment, for instance the Urban Area Development group in RE&H and the Spatial Planning and Strategy group in Urbanism. There are also close relationships with the Faculty of Technology Policy and Management (TPM), notably the TPM group working on Transport and Logistics with whom the group also co-operates in the TU Delft Transport Institute.

To enhance the co-operation between the sub-programmes, we run a seminar series, which facilitates scientific debate among researchers in different sub-programmes. Researchers from other programmes are also allowed to participate in the seminars.

3.1.6 Relations with education

The research group co-ordinates education for the domain Built Environment & Spatial Development at the Faculty of Technology Policy and Management (TPM). The OTB contributes to both the BSc Technische Bestuurskunde and the MSc Systems Engineering, Policy Analysis and Management (SEPAM). In the new programme for the BSc, four modules of five ECTS will be managed by the staff of this programme programme while also is contributed to other modules. But the research group will also contribute in other ways, such as supervising Bachelor's theses. In the MSc, four modules (of 18 ECTS in total) are managed by the research group. Contributions are also made to the 'design project' (in a TPM context, on system engineering, policy and management design) and to the supervision of Master's theses.

In addition to this strong educational grounding in the Faculty of TPM, the group also contributes to the Geography track at the University College Roosevelt in Middelburg. Occasionally the group contributes to other educational programmes, for instance through guest lectures and co-supervision of theses, at other faculties or educational institutions, such as the Faculty of Law at the Vrije Universiteit Amsterdam. Contributions are also made to teaching programmes in the rest of the Faculty of Architecture and the Built Environment, mostly those of Urban Area Development in RE&H and Spatial Planning & Strategy in Urbanism.

3.2 Description of sub-programmes and key research topics

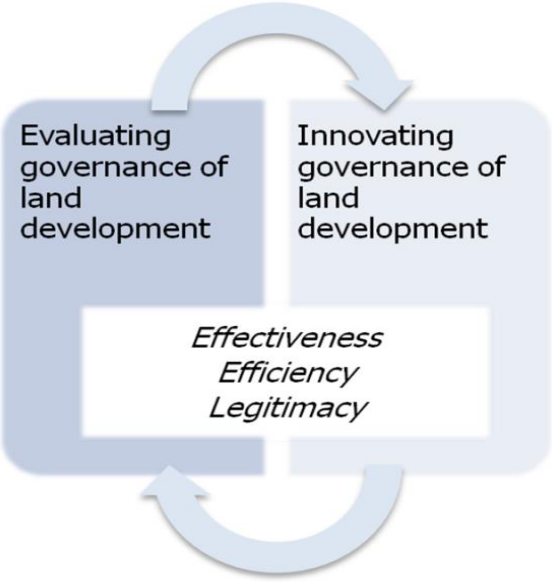
3.2.1 Governance of Land Development

Mission and research area
Governance of Land Development is concerned with the interaction between planning, property rights and property markets, the governance of the relationship between private interests of landowners and common societal goals.

Research into the governance of land development is about the transformation of land. Prime examples are turning agricultural land or rundown industrial areas into a new built environment or converting agricultural land into a biodiversity conservation area. Land development is analysed from a governance perspective. Governance involves the complex set of institutions that are drawn from governments. However, it goes 'beyond government' by involving 'the capacity to get things done' (Stoker, 1998). Thus, governance is not solely dependent on the power of government or authority. Rather, it also relies on practices in which managerial and entrepreneurial ways of working develop in tandem (Taşan-Kok, 2010; 2012). In land development, the relationships between public and private players are structured by their legal, economic and communicative resources. The institutions involved in land development are linked through power dependencies. The specific powers are vested in land-policy instruments, providing grounds for critical reflection on the way the authorities use such instruments and which strategies they pursue with these. This sub-programme builds on the former research theme Land Development and on part of the former research theme Land Tenure and Property Rights.

Evaluating and Innovating
Governance of land development is not a static activity taking place in a closed environment, so it is evaluated in this sub-programme with a focus on ways of innovating it. The underlying idea is that innovations may be based on evaluations of current governance practices and, vice versa, that innovations can be evaluated. Both evaluating and innovating have a normative dimension, which may be grounded in internal or external perspectives. Research from an internal perspective takes the aims of one of the players as its point of departure. For instance, does the governance of land development result in a more legitimate, efficient and effective way to achieve the goals of one of the players? In contrast, research from an external perspective uses broader external norms, which are not necessarily the aims of the specific player(s) studied. For instance, does the system of governance in land development contribute to sufficient competition on land markets, better cost management or to better solutions in terms of social cohesion, economic performance and social mobility? There are many possible perspectives lying between purely internal and fully external approaches; e.g., a study could focus on how urban resilience is organised in cities (Stead and

Taşan-Kok, 2013). Evaluation criteria are also time-sensitive: i.e., an evaluation should determine whether the governance of land development is open to the innovations that are necessary to meet the changing conditions. Innovations may also be prompted by new aims that make it necessary to change practices. These innovations usually take place in a context in which land development is structured by organising markets, i.e., the neoliberal agenda (Taşan-Kok, 2012). For instance, the organisation of the Single European Market (Fligstein and Mara-Drita, 1996) has a profound impact on the governance of land development (Korthals Altes, 2006).



In a field where both external and internal approaches are used, this sub-programme stays close to the governance operations that apply to land development. That is, the researchers look into actual governance issues: how pre-emption law works within the practice of land acquisition polices (De Wolff, 2000; De Wolff *et al.*, 2011; De Wolff and Groetelaers, 2005); they study and design how property rights can be used to improve the juridical architecture of the built environment (Ploeger, 2003; De Wolff, 2006; Groetelaers and Ploeger, 2007; 2010); they participate in an FP7 project on tenure law; they are well aware of which systems of land readjustment exist (De Wolff, 2004; Turk and Korthals Altes, 2011; De Wolff and Bregman, 2012); they have a broad overview of the policy instruments used in land development (Groetelaers, 2004; Groetelaers and Korthals Altes, 2004); they know how land development projects are calculated and administered by the authorities (Korthals Altes, 2010); and they know what contracts between development companies and local authorities look like (Van der Veen, 2009; Van der Veen and Korthals Altes, 2009; 2011; 2012). All in all, this sub-programme studies the instrumental debates that take place in the context of fixed and authoritative aims. The research may evaluate a particular use of instruments or propose innovations in their use.

However, the range of the sub-programme is not confined to evaluations and innovations from an internal perspective. One reason is that public authorities cannot afford to base their actions solely on internal interests, in view of the public accountability of legitimate authorities. A fair balance needs to be struck between public goals and private interests in relation to the protection of human rights in the application of land development instruments. That balance may be aligned with the European Convention of Human Rights (ECHR), in particular the fundamental rights to property (article 1, Protocol 1 ECHR), the protection of one's home (article 8) and procedural safeguards (article 6). The application of land development instruments generally interferes with the fundamental rights of citizens (Ploeger and Groetelaers, 2007; 2008). Moreover, the aims of the authorities are not determined internally but develop in response to the external context.

In relation to effectiveness, efficiency and legitimacy, this sub-programme takes the following stance.
On *effectiveness*, we will specify the internal effectiveness of a certain land development strategy and how that strategy relates to the aims of land development. We will co-operate with other researchers to share insights into the external effectiveness as it relates to aims outside the scope of land development. Consider the example of a programme to buy land

for biodiversity conservation. We do not have the expertise to assess ecological conditions directly, but we can reflect on the effectiveness of activities within the governance remit for land development. We take a similar stance on urban issues such as public health, transport, housing and economic development. The aim of the research in the sub-programme is to generate insights into the effectiveness of operations in a governance context through co-operation with other researchers to bridge the gap between internal and external effectiveness.

In relation to *efficiency*, we will mostly apply existing methods to analyse the costs and proceeds of projects, for instance discounted cash flow analysis. Although we do not expect to make scientific breakthroughs in economic or econometric methods to analyse land development, our application of existing methods to evaluate innovative practices may contribute to new knowledge.

Legitimacy is more than a question of legality; it is also about accountability. In the context of governance, authorities interact in horizontal relations with market players, citizens and organisations. These parties hold authorities accountable for their land development activities. Through these interactions, legitimacy is built up or eroded, as expressed in the general debates and guidelines on the relationships between the market and public authorities. The idea that governance goes beyond government gives new meaning to accountability and thereby gives legitimacy a pivotal role in many of our research projects.

Agenda

The current economic crisis has put pressure on the governance of land development, leading to demands for new ways of working (Groetelaers, 2011). This sub-programme will contribute to the debate by critically assessing the arguments put forward. It will also examine whether the proposed 'solutions' would be a good fit for the 'problems' addressed. Our contribution will be based on a fundamental approach to the following topics.

- The <u>authorities as land developers</u>. Governments as land developers and private enterprise as project developers: does it work? Can regional authorities be land developers? Is this arrangement financially sound? The flexibility of market players developing land raises questions about the way public accountability is organised. Questions about this role of authorities also pertain to complex development projects. What multi-level governance arrangements involving public and private players are made around these projects? Aspects of public accountability are at stake, also in relation to community involvement and community development. This debate is fuelled by the economic crisis and the idea that old-school practices in land development must be replaced by new ways of working that offer a better fit with the emerging 'new reality'. Can land development be made more adaptable?
- New <u>land development legislation</u>: better practice? The debates on the roles of agencies generate ideas for new legislation (instruments for land readjustment, cost recovery, pre-emption rights, compulsory purchase and new planning systems). Such legislation may give structure to urban and rural development. What role would be played by new land development laws, and the debate about such new legislation, in the process of legitimising the social practice of governance?
- The <u>Europeanisation</u> of the governance of land development. How does Europeanisation frame the constellation of actors, and which new modes of operation are emerging? What is the impact of the Single European Market? How are governance relations in land development structured by norms on the rights to property, respect for private and family life (including the protection of one's home) and procedural safeguards? Does Europeanisation affect rent law? How can governance of land development be made Europe-proof?

- The legal complexities of modern land use. New arrangements have sparked debates on land tenure and property rights in mixed use settings. Questions have also arisen about the effects of complex tenure structures for urban (re)development. How can the legal architecture of the built environment be improved? How do tenure law and property law interact in urban and regional areas and do these laws also refer to housing conditions? How do contracts structure urban and regional development?
- Innovative and participatory land policy instruments. A growing number of instruments (community land trusts, community benefits agreements, joint development projects, land readjustment, interim use, business improvement districts, industrial improvement districts, urban agriculture regulations, and the slow cities movement) promote the integration of diverse land uses and urban communities by participatory means. Essentially, they facilitate communication between spaces and communities. The evaluation of these innovative and participatory instruments is on the agenda of this research programme.
- Bridging internal and external effectiveness to attain legitimate governance of land development. The sub-programme aims to understand the relationships between internal and external effectiveness of land development governance and their implications for accountable land development. Can urban and regional resilience be developed through innovations in the governance of land development? Some examples of research topics are the following: the relationship between the neoliberal movement and land development governance; the idea of resilience as an overarching governance principle; and the way participatory land development initiatives may play a role in bridging internal and external forces in an innovative way.

'Modern land governance' requires new perspectives.

3.2.2 Territorial Governance

Mission and research area

Territorial Governance is concerned with how to improve the competitiveness, sustainability and resilience of cities and regions through innovation and change in governance.

Systems of territorial management around the world have changed tremendously in recent decades; the system in the Netherlands is no exception. New managerial approaches have appeared there in response to various shifts in the policy agenda. These were prompted by the globalisation of capital, the economic and financial crises, the predicted effects of climate change, the issue of energy security and resilience, for example. This sub-programme focuses on two key research areas: the dynamics of change (Shifts in Territorial Governance); and processes of transfer and learning (Territorial Governance and Learning).

Shifts in Territorial Governance

Shifts in territorial governance manifest themselves in many different ways. One important way is the transition from government to governance (Stoker, 1998). In the course of that transition, the number of actors engaged in policy making has risen, while non-governmental actors have increasingly become involved. Their participation has implications for the effectiveness of policies and projects (De Jong & Spaans, 2009; Spaans, Trip & Van der Wouden, 2013) as well as for legitimisation (mobilising affected citizens and societal groups). The shift from government to governance is closely aligned with the emergent concept of meta-governance, also known as 'governance of governance', and methods to influence self-organisation and policy integration (Jessop, 2002, 2004; Pedersen et al., 2011; Stead & Meijers, 2009; Zonneveld et al., 2012).

Shifts in territorial governance can take the form of rescaling – widening out (to higher levels), narrowing (to lower levels) and integrating (between sectors). Devolution, for example, is a form of narrowing, namely from national to lower levels. National control of competences from lower levels, on the other hand, represents rescaling in the opposite direction: a widening out of powers and responsibilities. In the Netherlands, certain responsibilities and powers for spatial planning have been devolved to lower levels of government (to the provinces and municipalities). As a consequence, the Dutch national planning system is no longer the comprehensive-integrated system it once was (Zonneveld & Evers,2014; Nadin & Stead, 2008; Spaans, 2006).

The European Union is shaping territorial development in the Member States through its environmental directives and territorial policies. This may be seen as the widening out of the responsibilities and powers for territorial governance (Waterhout, 2008; Faludi, 2010; Zonneveld et al., 2012). Its effect on area-based development in the Netherlands has been substantial (Evers, 2012; Waterhout, 2008). EU policy has prompted research and inspired discussion of the need for methodologies to assess territorial impacts and for suitable, user-friendly approaches to such impact assessment. These issues lie at the core of several projects in the European research programme ESPON (European Observation Network for Territorial Development and Cohesion) in which we have been participating (ESPON ARTS: Assessment of Regional and Territorial Sensitivity; ESPON EATIA: ESPON and Territorial Impact Assessment). The question of whether and how regulatory frameworks could offer greater potential for contextualisation in specific cases and places – a higher level of adaptation without lowering objectives such as environmental standards (Van Rijswick & Salet, 2012) – has become prominent. It is being dealt with in a dedicated NWO project in which we participate.

Some complex shifts in governance show up at the sub-national level due to the regionalisation of territorial governance. Trends towards territorial integration – especially the creation of urban regions in the Randstad – have propelled a search for new, appropriate levels of governance. But a match between territorial scales and levels of administration is no longer possible and should not even be pursued (Faludi, 2013). The question then becomes how to organise governance at the metropolitan level. In the 1990s, optimism about the prospects for strong, self-governing urban regions showing high levels of institutional capacity spurred the rise of New Regionalism. This optimism has since faded due to the unfulfilled promises of the concept. Recently, interest has been drawn to approaches for 'soft space' planning (Haughton et al., 2010). However, these approaches leave unanswered the important questions of legitimacy, accountability and effectiveness (Stead, 2013).


How to organize governance at the metropolitan level?

Another shift in governance relates to the inclusion or uptake of objectives, policy concepts and/or instruments originating in other policy domains. An obvious example in the Netherlands is the incorporation of water quality and water quantity principles in spatial planning. This interaction also works in the opposite direction, as territorial objectives – primarily spatial quality – are incorporated in water management policies, most prominently in the 'Ruimte voor de Rivier' (Room for the River) and Delta programmes (Meyer et al., 2012). The objective of boosting economic competitiveness is a case in point, as it has implications for investments in infrastructure. The impacts of such interventions on territorial development may be mixed (Meijers et al., 2012; Spaans et al., 2013). At the same time there is a tendency to make more land available for trade and industry than is justifiable in light of actual demand; instead of boosting competitiveness, the policy thereby induces municipalities to compete against each other (Louw & Bontekoning, 2007).

There are many examples of horizontal (or sectoral) shifts in governance. The objective of boosting economic competitiveness – especially that of cities and urban regions – has clearly been taken on board in territorial governance policies at all scales. Quality of place and territorial capital are important in this regard (Kloosterman & Trip, 2011; Trip & Romein, 2013). Climate change and resilience are also making their mark on territorial governance (Wilson & Piper, 2012; Stead, D. & Taşan-Kok, 2013). The same is true for the energy sector, which is also covered by the sub-programme. For instance, how is the structure of cities related to the uptake and production of renewable sources of energy? Is there a role for territorial governance in energy policy? These are some of the questions addressed in the FP-7 project PLEEC (Planning for Energy Efficient Cities) as well as in the ESPON North Sea STAR project. These projects started in 2013, and we are participating in both of them. The integration of policy on territorial development and its impacts does not always go smoothly, though; there are facilitators as well as inhibitors in play (Stead & Meijers, 2009).

Arranged under key words derived from the profiles given above, the following research topics on shifts in territorial governance provide a focus for external research funding bids as well as the uptake of new PhD students:

- Meta-governance, devolution, regionalisation and soft space planning: evaluation of changing patterns of territorial governance and policy integration, especially in relation to the Randstad and its South Wing.
- Europeanisation and territorial impact assessment: evaluation of the European dimensions of territorial governance and the impacts of EU sectoral policies on Member States and regions.

- Policy integration: 1) evaluation of the performance of urban regions and urban areas – including policies and strategies – in relation to competitiveness, environmental and health issues; 2) evaluation and impact assessment of major projects.

Territorial Governance and Learning

Attention is focused here on comparing and assessing territorial governance. Whilst comparative research is a well-established method of enquiry in the social and political sciences, it is somewhat less well developed in relation to territorial governance (Nadin & Stead, 2008; 2013). The relations between welfare systems, territorial governance systems and planning cultures and their parallels are of interest, especially in making links with welfare typologies (see, e.g., Esping-Anderson, 1990; Nadin & Stead, 2008). The explanation lies in the tendency to attribute a certain degree of autonomy to changes in systems of territorial governance while in reality these systems are embedded in wider governance and constitutional systems (Nadin & Stead, 2008; Stead & Nadin, 2011). For instance, there is a close relationship between the structure of the Netherlands as a decentralised unitary state and the distribution of competences in territorial governance across administrative levels.

Also of interest for this research area are the debates on the nature of territorial governance (Loughlin, 2007; Waterhout et al., 2013; Blotevogel et al., 2014)). It is questioned whether territorial governance systems converge, for instance through the effects of Europeanisation on planning (Dühr et al., 2007), or rather diverge in various directions, for instance through national forces like federalisation in Belgium or devolution in the United Kingdom (Stead, 2013).

The transferability of policies, concepts, procedures and instruments is another aspect of this research area, inspired by the literature on learning and lesson-drawing (e.g., Rose, 2005) and policy transfer (e.g., Dolowitz & Marsh, 1996, 2000; De Jong et al., 2002; De Jong, 2004; De Jong & Edelenbos, 2007). For instance, Spaans and Louw (2009) emphasise the interdependence of national context and the degree of policy transfer. Meanwhile, Stead (2012) has examined the development and transfer of best practices in spatial planning, and Stead et al. (2008) have discussed the transfer of West European ideas on public transport management in Central Europe.

The key research topics related to territorial governance and learning are the following:
- Developing and testing cross-national methods for comparing and assessing territorial governance systems and practice.
- Understanding the nature of changes in national territorial governance systems, especially the Dutch system in relation to systems elsewhere.
- The transferability of policies, concepts, procedures and instruments: learning and lesson-drawing.

Current and previous research programme

The current programme continues the main strands of research carried out under the previous programme. The research area 'shifts in governance' regroups but also refocuses some of the research areas covered by the previous programme. A prime example is that we would like to focus much more on the interrelationships between territorial governance and a number of policy areas that have a very strong territorial dimension. We have called this horizontalisation. This interest in relationships reflects the ascendancy of these 'other' policy areas due to developments such as climate change and the energy transition. It also reflects the gradual decline of a tradition of territorial governance ('ruimtelijke ordening' or spatial planning) and its partial replacement by combined approaches such as territory–water. A similar development seems to be taking place in a number of other countries (Blotevogel et

al., 2014). The exact nature of this horizontalisation is not fully understood though, and further changes are quite likely, making it an important topic for research. This contextual development has a strong and noticeable impact on research funding: 'spatial planning' as a distinct, separate research area no longer exists. The trend is toward combined approaches, in policy as well as research. This poses quite a challenge, as territorial governance research has to enter new domains.

3.2.3 Urban and Neighbourhood Change

Mission and research area

Urban and Neighbourhood Change is concerned with neighbourhoods and cities as changing social sites and as sites of governance and civic action, including the effects of neighbourhoods on residents and how residents affect neighbourhood stratification.

Neighbourhoods are still important in our daily lives, as places where we live, meet and interact with others, where our children play. People are willing to pay considerably more for a house if it is located in a 'good' neighbourhood (Cheshire, 2012). The Europe 2020 Strategy puts neighbourhoods at the core of our understanding of some of society's most pertinent socio-economic inequality problems. As that document emphasises, the disadvantage affecting people in situations of poverty and social exclusion is reflected and influenced by where they live (EC, 2010a; EC, 2010b). The neighbourhood is the scale at which many government services and provisions are made; it offers a venue for promoting and enhancing governance; and it is a scale at which people can be persuaded to get involved and feel a sense of belonging (Pill, 2012). The neighbourhood is also of interest in the context of health and ageing, as it provides opportunities for the (informal) organisation of care.

The neighbourhood has long been a site of government intervention in the battle against socio-economic inequality (Kleinhans, 2004; Kleinhans & Varady, 2011). In the last few decades, huge investments have been made by governments, housing associations and private developers in the physical fabric of cities and neighbourhoods. These investments were supposed to physically regenerate mainly 1960s and 1970s neighbourhoods. But their justification was also partly based on a strong belief among many policy makers that living in deprived neighbourhoods has an additional negative effect on residents' life chances over and above the effect of their individual characteristics: the so-called neighbourhood effects (Doff, 2010; Manley et al., 2013). A popular solution was to create socio-economically mixed neighbourhoods by accommodating social renters alongside homeowners. The effectiveness of such mixing policies is heavily debated, however (Kleinhans et al., 2007; van Ham & Manley, 2010; van Ham et al., 2012).

Studying the effectiveness of area-based interventions is more important than ever, now that the Western world is experiencing a major financial crisis. Many of the neighbourhood interventions of the past decades have drawn to a close, have been cut short or have been terminated. In this context it is important to investigate whether the belief in mixing is justified or not, whether there are solid grounds for area-based policy measures, and what the consequences might be of not investing in deprived communities (Manley et al., 2013). Against the backdrop of the current economic crisis and budget cuts, Western governments are increasingly searching for alternative ways to regenerate neighbourhoods and combat poverty and inequality. The idea is to recast state–citizen relations by promoting civil society and empowering citizens to help themselves (Wells, 2011; Manzi & Jacobs, 2011), especially in deprived communities (CLG, 2011; Kleinhans, 2012a). There is a need to find innovative ways to realise important goals in service provision, but without spending large sums of tax money. Stimulating civic action and promoting citizen self-organisation is high on the political

agenda, and actors like housing associations and (local) governments are adjusting to their new roles. This sub-programme will generate knowledge about the preconditions, supporting contexts and barriers to urban regeneration and the desired social outcomes.


Deprived neighbourhoods have negative effects on residents' life changes.

The Urban and Neighbourhood Change sub-programme is the successor of the 2009-2014 Neighbourhood Change and Housing research programme. This previous programme was focussed on the processes that affect the positioning of neighbourhoods in a stratification of places, neighbourhoods as places that are made through people's actions and the interactions between them, and as places of governance, with a constantly changing significance and meaning for matters such as social networks, identification and social interactions. The new sub-programme includes new elements and sets different priorities. These are steered by new theoretical challenges, the availability of new data and the recognition of new societal needs. The appointment of Prof. dr. Maarten van Ham as the new chair of Urban Renewal and a significant change in the staff have contributed to this change. Where the old programme consisted of three themes and five research areas (15 topics), the new programme focuses on three strongly interrelated broad themes: 1) *Neighbourhoods as sites of governance and civic action;* 2) *Neighbourhood change and stratification;* and 3) *Neighbourhood effects*. The new sub-programme is a step in the direction of a programme that is more academic in orientation, more international in scope and focus, and more orientated towards publication in international peer-reviewed journals.

Neighbourhoods as sites of governance and civic action

Spurred by the current crisis and the ensuing budget cuts, there is a clear shift from government to governance in urban and neighbourhood policy. Within this research theme we try to understand the changing roles of government and of institutions such as housing associations as well as the roles of professionals and citizens. The focus is now increasingly on facilitating and activating citizens to help themselves and improve their lives and residential environments. Often induced by self-interest and a drive to get things done, citizens engage in a range of activities, sometimes (un)deliberately taking over responsibilities that were formerly carried out by public or private bodies. The actions of citizens may therefore cause tensions with local authorities and other stakeholders. Also, the selective nature of civic action and citizen self-organisation may result in social inequality as well-equipped citizens may develop specific activities to the benefit of their own interests but which might exclude or harm others (Kleinhans, 2012b).

In the Netherlands there is a strong interest in the British concept of Community Enterprises (CEs). These distinguish themselves from other kinds of citizen initiative through their organisational form and goals. They are community-based, -owned and -managed businesses and develop non-profit activities aiding the regeneration of a particular neighbourhood or community. Important questions arise about CEs: How do various groups in neighbourhoods build structures for collective action? What is the role of institutions, mutual understanding of interests, power (im)balances and decision-making processes in how groups get things done in a local area? In response, governments are looking for new ways to communicate with citizens and activate them. Citizens, meanwhile, are looking for new ways to exchange information and mobilize others. There is enormous potential for participatory and empowering use of the Internet and social media, although such uses are still underdeveloped (Buccoliero & Bellio, 2010). Part of the potential of these virtual practices lies in engaging and reaching groups that are traditionally not involved in local initiatives.

Neighbourhood change and stratification

We can distinguish a hierarchy or stratification of neighbourhoods within urban areas based on socio-economic position, ethnic concentration and neighbourhood reputation (Hortulanus, 1995; Permentier et al., 2007). Spatial inequality should not be understood solely as the result of differentiation. It should also be seen as a cause of persisting patterns of differentiation, because competition among places can reinforce the existing stratification (Logan, 1978; Logan & Molotch, 1987). Within this theme we try to understand which social, economic and political processes, mechanisms and interventions affect urban neighbourhoods in their spatial, social and economic position. These include large-scale trends such as globalisation and individualisation, area-based interventions (including social-mix policies) (Boschman et al., 2013), social housing allocation mechanisms, housing policy (e.g., the Right to Buy), micro-level processes such as household change, (changing) residential preferences (Van der Laan Bouma-Doff, 2007) and residential moves. Neighbourhood change may be unintentional (spill-over effects) or intentional (for example, by branding, see Reinders, 2008; or as the result of social-mix policies, see Kleinhans, 2004).

We are interested in neighbourhood change itself as well as in neighbourhoods as changing social sites. A neighbourhood's population characteristics will change because of the selective inflow and outflow of residents and the in-situ changes of existing residents. These changes may show certain non-linear patterns with clear tipping points (Galster, 2012) and may lead to a downward spiral or to the gentrification of neighbourhoods. Also the significance and meaning that people attach to their neighbourhood can change. We therefore investigate their neighbourhood ties, examining how meanings and ties originate and develop in and through social relations (Van der Land & Doff, 2010) and how these processes serve as building blocks of relations between people and places. Within this context, we are interested in the role of public spaces in the (re)production of ties with and in neighbourhoods and the ascription of meaning to them. For instance, we study how claims on public space (for example by youth, see Binken & Blokland, 2012) may conflict with the potential claims of others.

Neighbourhood effects

Within this theme we aim to develop a better understanding of the relationship between socio-economic inequality, poverty and neighbourhoods. The book *The Truly Disadvantaged* (Wilson, 1987) has generated unabated interest in the neighbourhood effects on school dropout rates, childhood achievement, transition rates from welfare to work, deviant behaviour, social exclusion, social mobility, income, etcetera (see for a review Ellen & Turner, 1997; Galster, 2002; van Ham et al., 2012). Theoretical explanations of neighbourhood effects include role model effects, peer group influences, social and physical disconnection

from job-finding networks, a culture of poverty leading to dysfunctional values, discrimination by employers and other gatekeepers, access to low-quality public services and exposure to criminal behaviour (Galster, 2012). The strong belief in neighbourhood effects has contributed to the development of area-based policies promoting a more 'favourable' socio-economic mix in deprived neighbourhoods. However, there is little consensus on the importance of neighbourhood effects, the underlying causal mechanisms, the conditions under which they are important and the most effective policy responses. It is likely that most studies claiming that poor neighbourhoods make people poor(er) only show that poor people live in poor neighbourhoods because they cannot afford to live elsewhere (see Cheshire, 2007; van Ham & Manley, 2010).

According to Small & Feldman (2012), neighbourhood effects research is at a crossroads since current empirical and theoretical approaches do not seem to be moving the debate forward. A recent paper by Van Ham and Manley (2012) has set out an ambitious research agenda, formulating ten challenges for future research. Within this theme we will take up several of these challenges, most notably the following: to make better use of individual-level longitudinal survey, administrative, register and census data; to move away from single point-in-time measures of neighbourhood characteristics and to take into account people's neighbourhood histories (Sharkey & Elwert, 2011; van Ham et al., forthcoming); to investigate intergenerational neighbourhood effects (Hedman et al., forthcoming); to understand neighbourhood choice (Doff & Kleinhans, 2011) and to incorporate choice explicitly in models of neighbourhood effects; and to include other spatial contexts in addition to the residential neighbourhood.

3.2.4 Urban Systems and Transport

Mission and research area

The UST sub-programme is concerned with how the built environment interacts with spatial and transport behaviour, how this interaction influences urban performance, and how it can contribute to more competitive, sustainable and liveable cities.

Background

Urban systems are networks of towns and cities, their suburbs and their hinterlands. They can be seen as systems since they depend on the movements of people, goods and services, capital, data, information and ideas through the networks. Transport is deemed essential to their functioning.

Transport has always been decisive for urban development. In the past, cities emerged at the intersections of infrastructure. Even so, most activities took place within the cities, which can be characterised as monocentric. Transport became faster and cheaper as modern transport modes, in particular the car, were made available. As a result, our prosperity and lifestyles are dependent on a growing diversity of activities. In order to fulfil an expanding range of wishes and needs, people increasingly take advantage of the specific characteristics of a variety of locations for living, working, shopping and leisure. Likewise, business processes have become spatially fragmented, making use of specific local advantages such as cheap land or labour or high-quality facilities (Hall and Pain, 2006; Levinson, 2008;; Bertolini, 2012). It is through transport and communication technology that the spatially dispersed activities are connected.

Although transport plays an essential role in urban systems, it also has some drawbacks. On the one hand, negative effects appear in the system itself: reduced accessibility due to traffic congestion, lack of parking facilities and delays in public transport; and the exclusion of those who do not have full access to transport. On the other hand, transport is associated

with externalities: energy consumption, emissions, unsafe conditions and the deterioration of landscapes and communities. Many solutions have been put forward, which fall under two approaches (Owens, 1995). One, to 'predict and provide' traffic infrastructure, is increasingly regarded as a less desirable solution, given the rise of environmental awareness and evidence that new roads will simply induce more traffic (Baum-Snow, 2007a,b; Cervero, 2002). The other, to 'predict and prevent', reduces car traffic demand but ignores our dependency on rapid and cheap transport. The challenge is to find a balance between the two approaches (e.g., Banister, 2005); so far, however, little progress has been made.

A fundamental research question is whether, and if so how, spatial developments determine travel behaviour. The answer is often embedded in an analysis of the 'land-use transport feedback cycle' (Wegener and Fürst, 1999). That feedback cycle operates within the spatial structure of homes, jobs and facilities that form the framework through which people travel. Spatial interactions between these activity locations occur by means of the transport system, which in turn determines the accessibility of locations and consequently the attractiveness of locations. It has been known for decades that suburbanisation (or urban sprawl) and the growth in car use mutually reinforce each other. Sprawl encourages travel over longer distances and criss-cross traffic, both of which favour cars, while more concentrated urban development favours public transport.

An idea that has taken hold is that reversing the suburbanisation trend through compact urban development will help control vehicle travel (Banister, 1997; Handy, 2005; Van de Coevering and Schwanen, 2006). The Netherlands has a long tradition of intensive spatial planning as a way of influencing travel behaviour (Dieleman et al., 1999), primarily by encouraging people to live and work at the level of the urban region. On top of that, it was assumed that higher densities and diversity tend to shorten necessary journeys, thereby reducing daily travel pattern kilometres and bringing frequent destinations within walking or cycling distance. Furthermore, higher densities were assumed to provide a better population base for public transport. Although such ideas have been upheld elsewhere in Europe (Geerlings and Stead, 2003), nowhere have spatial planners attempted to influence travel behaviour as rigorously as in the Netherlands (Banister 2002). In the USA, initiatives to implement land-use concepts are generally supported by private movements such as Smart Growth and New Urbanism, primarily on the level of neighbourhoods.

The body of research on the relationship between the built environment and travel behaviour is vast (e.g., Ewing & Cervero, 2010; Van Wee & Maat, 2004). Nonetheless, research to test the influence of the Dutch policies has been unable to substantiate the assumed effects with any more convincing evidence than elsewhere (Schwanen et al., 2004; Snellen & Hilbers, 2007). Although the argumentation behind these spatial concepts sounds plausible, the simple reasoning is not supported by empirical findings, suggesting that other mechanisms complicate the relationship. Rather than the built environment having a straightforward influence, we find endogenous relationships in which individuals take into account other preferences, other activities and travel, other people and other locations (Maat and Arentze, 2012).

In the predecessor of this sub-programme, we explored a number of these complexities. It was shown that behavioural mechanisms are never simple but invariably elicit compensation and rebound effects. For example, higher densities bring shorter distances and more chain trips, which cut travel time, but the freed-up time is spent on latent activities that are within reach (Maat et al., 2005; Maat & Timmermans, 2009). It is said that the reason why individuals do not exhibit specific types of behaviour is not because the built environment leaves them no choice. On the contrary, they opt for a specific urban form because they prefer a

specific travel pattern, referred to as residential self-selection (Cao et al., 2009). Bohte et al. (2009) explored this assumption and found that households are often mismatched concerning their satisfaction with housing and the residential environment versus their travel-related preferences. In research on bicycle commuting, although the key limitation for cyclists is travel distance, which can be shortened in compact cities, many more reasons are found to play a role, including attitudes of the employee and the employer (Heinen et al., 2011, 2013). Other complexities include land use, supply and economic dynamics, and the supply side of transport systems, such as technological innovation (Bertolini, 2012). One of the areas of technological innovation that we have explored is electric mobility; we studied the options to pave the way for a large-scale introduction of electric vehicles (Sierzchula et al., 2012; Konings, 2013; Bakker et al., 2014).

Complex relationships between travel behaviour and the built environment.

At an aggregate level, travel behaviour as well as other types of flows constitute a fundamental element of the spatial organization of territories. In the contemporary debate, particular attention is also paid to the question of the spatial organization of systems of cities on a regional scale. The rise of the polycentric mega-city region has been heralded by several key scholars in the field of urban and regional studies. The coalescing of once distinct and relatively independent cities into polycentric regional urbanized entities, whether 'mega' or small, is linked to the transition from an industrial to a post-industrial era and as such, can be considered the spatial manifestation of changes in economic, political-institutional and advances in communication and transport technologies and other technological processes, most notably globalization. Whatever concept authors use (e.g. networked city, global city-region, regional cities, megaregions, polycentric urban region or polycentric mega-city region), they all stress the key features of 1) polycentricity, which means that mega-city regions are made up of multiple cities hosting key urban functions, and 2) the existence of increasingly strong functional, administrative and possible cultural ties between them. The latter is also referred to as the process of 'metropolisation' (Meijers et al., 2014).

This spatial transformation of the industrial city to the polycentric, functionally networked (mega)city region poses tremendous new and fundamental challenges for research, for instance relating to their internal and external relations (Scott, 2001; Kloosterman and Musterd, 2001) and how these interact (Hoyler et al., 2008), the development of functional specialization and spatial complementarities (Hall and Pain, 2006) and notably also its policy implications (Ross, 2009). In addition, the performance implications of their polycentric urban form is often questioned (Lambooy, 1998; Kloosterman and Musterd, 2001; Parr, 2008; Meijers and Burger, 2010), while also the need for more conceptual clarity has been stressed.

Research gaps

It is a challenge to understand the urban and transport system and then to translate the insight thereby gained into guiding principles for practice. After all, it is they who will have to find a balance between providing accessibility and reducing the negative effects. This subprogramme is focussed much more closely on transport than the previous one, and its aim is to contribute to the development of socially, economically and environmentally sustainable cities. Below, we identify the research gaps we intend to address.

First, it is crucial to examine the relationship between the built environment and travel behaviour within a timeframe. It has often been argued that infrastructure and urban form have consistently reinforced each other. However, this has rarely been tested empirically over a long period (e.g., Koopmans, et al. 2012), partly because of the lack of data sources. Closely related to the timeframe factor is that response times vary within the land-use transport feedback cycle. Activity patterns change quickly whereas land use and transport systems change slowly (Bertolini 2012). One example of a research topic is the extent to which compact urbanisation has an effect on residential mobility and consequently on travel behaviour. Another long-term influence that has scarcely been addressed is the household life cycle. In light of the self-selection hypothesis — that household location choices are partly based on attitudes towards travel behaviour — key events might induce changes in lifestyle and attitudes over time, resulting in mismatches between location and travel (Schwanen & Mokhtarian 2005). Parts of this line of research have been started.

Second, it is highly important to forge linkages between academic research and planning practice, preferably through real-world experiments (Bertolini, 2012). Policy makers and academics tend to compare results internationally. However, it is legitimate to ask whether foreign research is actually transferable. Mechanisms described in studies from a different continent should never be deemed applicable without qualification. The findings must first be tested, preferably by designing a comparative international study in which data on travel behaviour, the built environment and other individual and household characteristics are collected in both countries and analysed in the same way. Two such studies have been started.

Third, the field of transport modes is very dynamic. The most striking development is the transition from cars with an internal combustion engine to electric vehicles, which may pose a threat to some parties and a challenge to others (Van Wee et al., 2011). The transition will make cities cleaner but also create spatial challenges and effects related to parking, charging and changing driving behaviour. Because the bicycle has positive effects on the environment and health (Handy et al., 2002), it is a promising mode of transport. There are several issues, though: parking problems in inner cities and at railway stations (Maat and Louw, 2013); the role of the electric bicycle and its substitution for conventional bicycles or cars; and bicycle sharing. The emerging combination of the public transport system and compact urbanisation, referred to as Transit Oriented Development, originated in the USA (Cervero, 2003). Although theoretically promising, there are some uncertainties about this combination: to what extent, and under what conditions, would individuals be willing to attune their residential and work location choices and travel behaviour to the TOD model; whether companies are willing to relocate; and whether other stakeholders are willing to develop at nodes.

Fourth, the accommodation of urban freight transport (UFT) is vital to urban life. For almost all urban activities, goods have to be delivered (to shops, restaurants, fuel stations, schools, hospitals, offices, construction sites, etc.). Obviously, the performance of UFT depends not only on the characteristics of its transport system (which is nowadays strongly road-oriented) but also on the context in which it has to operate, i.e., the urban structure. Unlike 'passenger

travel', the 'urban structure' is a relatively untapped area in the study of UFT. Research into such interactions touches upon the impact of existing and emerging patterns of urban activities (shopping, business and leisure) such as the emergence of e-shopping. So far, very few studies have empirically investigated the implications of e-shopping for freight transport (Rotem-Mindali et al., 2013). Common sense suggests that e-shopping can lead to more efficient freight transport and be environmentally responsible. Nonetheless, it should be considered in relation to the dynamics of household travel patterns, which makes the issue much more complex (Cullilane, 2009). Such interactions between urban freight and passenger travel are still unexplored.

Fifth, despite widespread recognition of the spatial transformation from city to mega-city region, it is striking to observe that many theories once developed with the now obsolete image of the industrial city in mind are still omnipresent and often direct empirical research onto a too narrowly defined spatial scale. Consequently, research often fails to capture the complexities, networks and resulting interdependencies inherent to urban systems on a supra-local scale, and the associated likely process of a spatial rearrangement of urban functions. The aim of the research is to address this mismatch. One of the research issues concerns the theories on the effects of agglomeration, their current basic assumption being that these effects are confined to well-defined single urban cores, while it could well be that they extend over larger regions through processes of 'borrowed size', 'agglomeration shadows' (Burger et al., 2014) leading to 'city network externalities'. The question then is whether networks of cities may be able to substitute for the effects of agglomeration. This links to new paradigms in urban studies and planning that emphasise the importance of cities' embeddedness in networks of all kinds – business, capital, knowledge, people, goods – for their performance (Massey et al. 1999; Sassen 2002; Taylor 2003; Hall and Pain 2006; Neal 2012). Particular attention will be paid to the role of infrastructure networks and transit systems in facilitating this substitution process and hence, raising the performance of metropolitan areas. More generally, we study what is termed the 'process of metropolisation', and consider how functional coherence (as evidences by flows between places) is related to institutional and socio-cultural coherence, thereby extending theories on the connection between people and places and linking the research to regional governance. In addition, this process of metropolisation requires to be linked to the performance of cities and city-regions. Clearly, the coalescing of cities into larger (mega)city regions does not imply just another higher spatial scale of analysis. Instead, these challenges demand novel methodological approaches and ground-breaking empirical research to arrive at new theories on the spatial organization of urban systems, on the geographic foundations of agglomeration economies and on 'people-place' relationships. A common denominator of this research challenge is that urban form is linked to performance in terms of environmental sustainability, economic competitiveness and social well-being, and that in studying this link we consider the interaction with socio-cultural, institutional and behavioural dimensions.

Approach

This sub-programme intends to continue its fundamental approach by attracting PhD and postdoc research and publishing in international peer-reviewed journals. Its aim is to deliver theoretical and empirical research using state-of-the-art quantitative and qualitative methods, including web-based surveys and GPS-based data collection methods (Bothe and Maat, 2009), statistical and GIS analysis methodologies, and support of qualitative methods. It is our goal that not only the academic community but also planning practice and education will benefit from our research.

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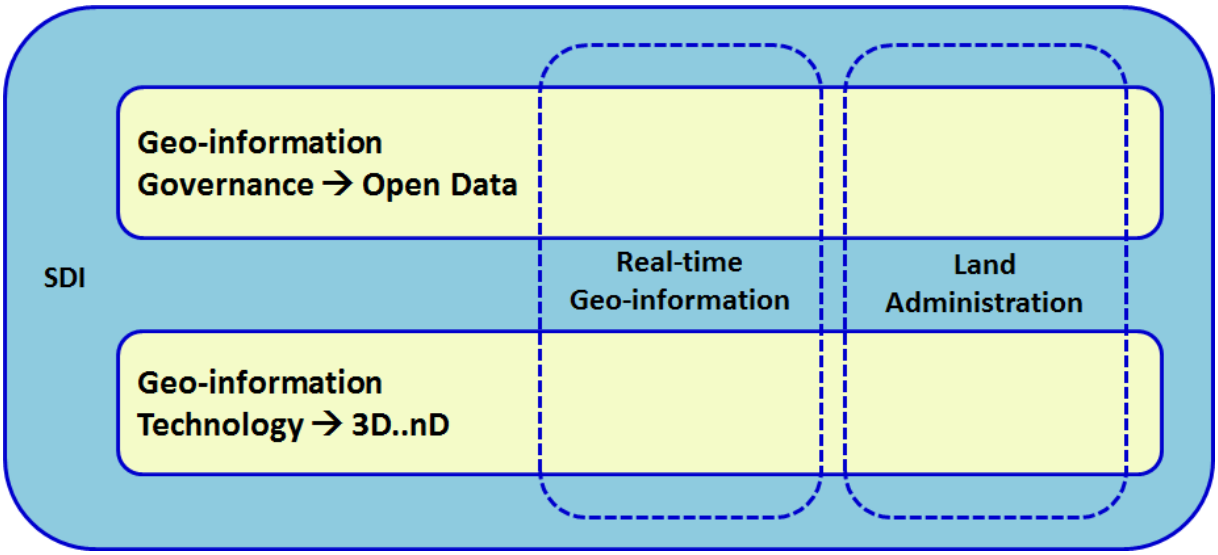
4 Geoinformation Technology and Governance (Geo-TG)

4.1 Introduction to the programme

The Geoinformation Technology and Governance (Geo-TG) research programme is dedicated to both the technology and the governance aspects of the spatial information infrastructure, which is also called the Spatial Data Infrastructure (SDI or geoweb). The research programme leader is Peter van Oosterom. The information infrastructure serves numerous domains, two of which are part of the programme: Land Administration and Real-time Geoinformation (such as navigation, smart cities, crisis management, etc.). The technology component deals with connections between various information sources for enabling data sharing, updating and reuse. The information increasingly involves extra dimensions (height, time, scale): 3D..nD. The governance component investigates legal and organizational issues (such as open data, privacy, copyright and databank rights, business models). The figure below shows the relationship between our two sub-programmes (Geoinformation Technology and Geoinformation Governance) and the domains.



4.1.1 Mission and research area

Mission: 'Geo-serving the networked society via top-quality geoinformation technology & governance research and education towards sustainable SDI'

The SDI serves the same purpose as the nerve system does in humans. The nerve system is crucial for the functioning of humans and covers the information flows from sensory receptors (seeing, hearing) via processing, analysis and planning (storing information, thinking) and communication (in speech and writing) to control actions (walking or moving in other directions, buildings). Our society has realized this and is now heading towards a sustainable SDI in which spatial information or geoinformation can be shared and reused. This demands the development of appropriate technology – services, protocols and standards for national and international SDIs – as well as the advancement of the geoinformation to 3D and nD

(with scale, time, considered as dimensions). Which models are most appropriate for specific geoinformation? How to manage big data? How can we ensure the prompt delivery of data to users with time-critical needs, while maintaining quality control and accessibility for lower-priority users? How should we prepare geoinformation for different display devices? How can heterogeneous data flows be processed quickly enough to prevent data volumes from overwhelming managers and users?

SDIs require appropriate legal and organizational regulations. The focus of our research is on open data. Recent research shows that open data has great economic and societal impact. The European Union advocates open data through the Directive on the Re-use of Public Sector Information. The greater availability of public data is expected to catalyse the secondary use of such data, which will lead to a growth in information and greater government transparency. The reuse of public data has commercial potential, but also raises societal questions. For example, how to resolve the conflict with the individual's right to information privacy as protected by the European Data Protection Directive? Will open data result in unfair competition with the private sector and put society at a higher security risk when 'national security data' is provided openly?

4.1.2 Updating and merging of previous programmes

The current Geo-TG research programme is rooted in the earlier 2009–14 programmes of GIS technology (GISt) and parts of Governance of Geoinformation and Land Development (GiGb). Of the latter, especially the former theme groups 'Land tenure and property rights' (focus on the content of the legal relations between people and land, especially in the field of the multiple use of space, the transparency of the way these legal relations are implemented by land administration authorities, and the balance of public and private interests) and 'Geoinformation studies' (focus on the institutional arrangements whereby spatial information is provided for the public sector by private companies and private persons).

4.1.3 Scientific relevance

Geoinformation technology and geoinformation governance are part of the more general discipline of geoinformation science. The impact of geoinformation is growing, as it can be readily transported by electronic means via wired and wireless networks. Geoinformation is increasingly combined with emerging sensor, visualization and interaction technologies. Many applications make use of geoinformation and related technologies. 3D solutions – which take into consideration the space below and above the surface, indoor and outdoor, and the design and existing situation – are merging. Time and scale are becoming increasingly important and need to be integrated as dimensions for efficient and consistent management.

The most important innovations in geoinformation technology & governance research are characterized by infrastructure concepts for the handling of geoinformation. Analysis of the three selected application areas (Land Administration, Crisis Management and SDI) and their current deficiencies allows us to trace knowledge gaps. Further research is subsequently used to develop improvements and solutions, which are tested in practice. An analysis of changing geoinformation application requirements reveals a number of transitions, which are either on-going or expected to take place in the near future. These transitions must be supported by scientific/technological and societal innovations. The five main transitions are: 1. from ad hoc (project) spatial information to SDI; 2. from static 'maps' to dynamic models of space; 3. from traditional map production to dynamic (possibly participatory) data collection and positioning 'on the fly'; 4. from the implicit semantics of geoinformation to explicit knowledge; and 5. from institutional closed data to open data. The research objective is to

provide technological and governance support for the realization of SDIs, with a special emphasis on the core geo-DBMS (database management system) technology and geo-data policies. The aim is to make TU Delft one of the top three universities in the world in the field of geoinformation technology & governance.

4.1.4 Societal relevance

Selected domains within the research programme focus on the societal relevance (and are used for the motivation and the assessment of the research results from both sub-programmes): Land Administration, Spatial Data Infrastructure (SDI), and Real-time Geoinformation. The research is complemented with the development of tools, which are made freely available to society at http://www.gdmc.nl/projects.

The programme participates in international and national networks with such diverse partners as the European Commission (European Location Framework project with 30 partners); Rijkswaterstaat, the Ministry of I&M, the Ministry of ELI, KNAW-NCG, sector associations such as GeoNovum, the National Spatial Data Infrastructure (NSDI) executive committee in the Netherlands, local authorities, market players and their professional organizations.

Staff members of the programme actively participate in standardization activities via membership of various committees and expert groups at both the national and the international level (in the Dutch Standards Institute NNI and the ISO, respectively), the ISO 19152 (Land Administration Domain Model) Committee and the NNI Geoinformation Committee. They also support and actively participate in the Dutch Geoinformation Association (Geo-Informatie Nederland; GIN) and the Netherlands Centre for Geodesy and Geoinformatics (NCG) and two of its sub-commissions (Geoinformation Infrastructure and Core Spatial Data). Collaboration with the international geo-IT industry is essential for our research (Oracle, Bentley Systems, Safe Software). These companies participate in the Geo Database Management Centre (GDMC), a research and development centre that is hosted by TU Delft (www.gdmc.nl).

4.1.5 Internal and external collaboration

The group collaborates with several other groups within the Faculty of Architecture and the Built Environment: the Housing Systems group on housing markets in relation to land markets; the Housing Quality and Process Innovation group on building regulations; the Urban Renewal and Housing group on the organization of urban renewal; the Urbanism group on analysing GPS (and other positioning technology) traces; the Design Informatics group on 3D modelling and BIM (Building Information Modelling). Hendrik Ploeger occupies the chair of Real Estate Law at VU University Amsterdam.

At an international level, researchers actively participate in: the Association of European Schools of Planning (AESOP); the European Network of Housing Research (ENHR); the International Federation of Surveyors (FIG); the International Society for Photogrammetry and Remote Sensing (ISPRS); the Open Geospatial Consortium (OGC); the Association of Geographical Information Laboratories in Europe (AGILE); the Urban Data Management Society (UDMS); European Spatial Data Research (EuroSDR); the Global Spatial Data Infrastructure Association (GSDI). The group also has contacts with international organizations in this field, such as UN Habitat, the World Bank and FAO.

There is international collaboration with many foreign universities, e.g. Wuhan University, China; University of Seoul, Korea; Universiti Teknologi, Malaysia; University of Queensland, Australia; University of Aveiro, Portugal; Universidad de Jaén, Spain; Universidad del País Vasco, Spain; Karadeniz Technical University, Turkey; Middle East Technical University, Tur-

key; University College London, England; University of Glamorgan, Wales; TU Wien, Austria; University of Applied Sciences Stuttgart, University of Heidelberg, Leibniz University Hannover and the Weierstrass Institute for Applied Analysis and Stochastics (WIAS), Berlin, Germany. Peter van Oosterom is the Delft scientific director of the Wuhan-Delft Joint Research Centre on Spatial Information (JRC-SI).

4.1.6 Relations with education

The MSc Geomatics for the Built Environment (120 ECTS) education is mainly delivered by the OTB sections GISt and GiGb. Geomatics is a relatively new science concerned with the analysis, acquisition, management and visualization of geographic data with the aim of gaining knowledge and a better understanding of the built and natural environments. Geomatics is a regular Master's programme of the Faculty of Architecture and the Built Environment. The programme has recently (2012) been positively assessed by a review committee. Increasing the student numbers and better embedding within the Faculty of Architecture are priority areas.

The MSc Geoinformation Management and Applications (GIMA; 120 ECTS) is a collaboration with three other Universities: UT/ITC Enschede, Utrecht University and Wageningen UR. Here, TU Delft/OTB is a full partner and equal owner of the programme. At the beginning of each module, there are three contact days, followed by a 12-week period of distance learning. The programme is concluded with two examination days at one of the four universities. GIMA is offered both as a full-time programme (two years) and as a part-time programme (four years).

The group makes a modest contribution to various courses on land use and land development at both the BSc and the MSc level in the Systems Engineering Policy Analysis and Management (SEPAM) degree programme of the Faculty of Technology, Policy and Management (TPM).

The most up-to-date knowledge and experience in geoinformation is bundled in a joint national geoinformation minor (30 ECTS), in which the following partners cooperate: Utrecht University, Groningen University, Free University Amsterdam, Wageningen UR, University of Twente and TU Delft.

Our researchers supervise students during their graduation projects in both Geomatics and GIMA. There is a good mix of internal and external MSc thesis projects. Most MSc thesis research leads to professional or scientific publication(s), often in collaboration with the members of staff who supervise the research.

4.2 Description of sub-programmes and domains

The Geo-TG programme consists of two sub-programmes: Geoinformation Governance – which researches the institutional, legal and organizational aspects of sharing and using/reusing geographical information, with a special focus on open data – and Geoinformation Technology, which investigates geoinformation handling tools, with a specific focus on developing the '5D model' (deep integration of 3D space, time, and scale) as the basic concept.

The two sub-programmes form the basis for three domains: 1. Land Administration, 2. Spatial Data Infrastructure and 3. Real-time Geoinformation.

4.2.1 Geoinformation Governance

Access to geoinformation is important for the wellbeing of society. Technological advances allow access to a wide variety of geoinformation and the use of sophisticated new access methods. However, these technological advances pose a challenge to existing institutional principles concerning access to geoinformation, and will continue to do so in the future. In view of these technological advances, the accessibility of geoinformation from an institutional perspective with special reference to three user segments:

- The geo market, and in particular the position of (private sector) value-added resellers here.
- Geoinformation within the context of e-government (e.g. European INSPIRE, Dutch base registrations and sector arrangements).
- The general public (citizens), both as users/end-users and increasingly as data providers.

In this research sub-programme, the group will focus on one of the most promising policies promoting the accessibility of data: open data policies. The research focuses on the governance of open data, its societal and economic impact, and the legal restrictions on or conditions for implementing and utilizing open data policies.

Vast amounts of geo-data are constantly collected and processed in response to specific user needs. Nevertheless, much geo-data can also be used for other objectives, with little or no need to re-collect or reprocess it. Since the sharing of geo-data is considered to be in the general interests of society as a whole, there is an overall drive to increase the sharing by improving access, removing technical, legal and financial barriers, and devising appropriate organizational structures without forgetting the possible consequences for the freedom and privacy of individuals. In other words: the research aims to stimulate the organizational and legal interoperability of geo-data; that is, the legal, organizational, semantic and technical interoperability in interrelation to each other and the political context in which they are developing.

Increased efficiency: technology has provided new ways of sharing geoinformation among different organizations. A number of programmes at the national level (e.g. the Dutch e-government programme 'Different Government') and the European level (in particular INSPIRE, the EC Public Sector Information (PSI) directive, GMES, Galileo and the EC Water Framework Directive) have made people – at least those within the geoinformation sector – aware of the need for increased data sharing and improved access. The final legal outcomes of these programmes are, however, quite limited in their prescriptive provisions.

Service provision: public sector or market? New technologies provide new opportunities to provide geoinformation answers to today's societal questions. At the most basic level, Google Earth and Bing Maps are examples of commercial access points that bring together data from public, private and other sources. Other more advanced services provide opportunities for the public sector to inform and involve citizens as part of e-government programmes. The public sector also employs special modules to receive feedback from well-informed citizens in a way similar to that used by the Landesvermessungsamt (regional surveying service) in Nord Rhein–Westphalia (Germany) for its topographic mapping. This may result in new public activities that used to be the domain of the private sector, possibly changing the balance between market activities and public sector activities.

New business models required? The new technology has also led to a shift in business methods away from the traditional sale of services to, for example, employing free services to generate 'traffic', which attracts companies that want to put their advertising banner on the site in question. Intellectual property rights were traditionally used to protect a product in

order to generate revenues from sales, but are now used to attract customers through freely available products as a way of merchandizing other products. The question arises whether government can still rely on the traditional business models when these new ways of doing business become increasingly common (people will expect or even require free access to data). Digital rights management (DRM) systems may provide feasible solutions to this problem.

SDI assessment frameworks: technological developments influence not only the access to geoinformation, but also the roles played by citizens and the public and private sectors in the SDI. The traditionally dominant national mapping agencies (such as the Ordnance Survey in the UK) may need to switch from a leading to a more secondary or facilitating role. Citizens and the private sector might become the drivers for future development. Geoinformation might become like other infrastructures such as water and electricity supplies, which are only noticed when they break down. This new infrastructural role for geoinformation might require a reassessment of not only the required data quality characteristics, but also the access policies accompanying the data. This increasingly calls for the continuing development of an SDI assessment framework. The research aim is to include the assessment of the institutional component of SDI as one of its research topics.

Public use of geoinformation.

New role for government? Data used to be available only from one or a few public data providers. Nowadays a wide range of similar data are often offered by many different public, private and other parties. The citizen's involvement has been stimulated by hand-held GPS receivers, and further promoted by the locational tools incorporated in smart phones. The data collected by these non-professionals goes far beyond traditional limits. Examples are Google's Street View, YouTube and Open Street Map, where citizens create topographic maps with a GPS receiver and a simple GIS tool. TomTom (the former TeleAtlas) also offers many gigabytes of video data of the road network that may be used for 3D animations. Now that new technology is moving data collection away from its traditional roles, will the role of government shift from data provision to quality control and certification?

New threats? Technological advances also pose new threats to society. For example, locational tools may enable location-based services (LBS), but also diminish privacy. The issue of privacy protection sparks public debate every time technological developments permit or simplify the collection, combination or application of new sets of person-related data. In addition, privacy concerns and data protection legislation are major barriers to the implementation of open data policies. These new technologies also challenge existing institutional arrangements protecting privacy. While technology is typically introduced on a global scale,

legislation addressing new technological threats is traditionally a national responsibility. The pace of technological development sometimes tends to outstrip the development of privacy protection, which also puts personal privacy at risk.

Approach

The main institutional aspects on which the Geoinformation theme group focuses are:

1. Open data policies and their legal and financial context, including privacy, intellectual property rights and DRMs, harmonized licensing agreements and business models.
2. The dynamics of the roles of stakeholders within SDI and the thin line between government control and what is better left to the private sector; the increased role of non-professionals in information gathering and its impact on the traditional geo-sector.
3. Assessment of the success and impact of the development of (in particular national) SDIs on the use of geoinformation in society, with special reference to the influence of European directives and the differences in implementation of these directives in the various Member States.

As the application and user context are considered in each case studied, the three above-mentioned segments will be highlighted to varying degrees in different cases.

A comparison of the developments in different European countries, especially in relation to the implementation of EU directives, is the main route followed in the development and testing of conceptual models and also acts as a source of inspiration for various solutions. The results of our research are shared with, and compared with the results of, peers throughout the world, and especially in the North American and Asian Pacific regions; the Global Spatial Data Infrastructure Association is an important platform for such exchanges. The theme group also receives input from the Dutch public policy and private sectors, and has significantly influenced developments in these sectors.

4.2.2 Geoinformation Technology

The Geoinformation Technology sub-programme concentrates on a '5D model' (deep integration of 3D space, time and scale) for both discrete and continuous spatial phenomena as a basic concept for SDI. To achieve this deep integration, information models will have to become more and more formal, for example through an increased stress on ontology. The main features of the SDI based on a DBMS (database management system) with the 5D model at its core, to be realized in the long term, are integration of the various datasets involved (e.g. indoor/outdoor, surface/subsurface, designed/surveyed), real-time or at least 'daily fresh' maps (via sensor web + formal semantics + automatic processing), combined with positioning and wireless communications technologies (to enable the system to deal with moving objects).

The main innovations relate to thinking in terms of infrastructure when developing geoinformation handling systems (which requires technological innovations enabling optimum use of geo-data and services). The foundation of SDI consists of geo-DBMSs filled with geographical data. All research projects cover such topics as 3D spatio-temporal modelling, computational geometry (spatial data structures/algorithms), distributed geoinformation processing (network protocols/interoperability/web services/grid & cloud computing), mobile GIS (LBS) and knowledge engineering (ontology and semantics).

In addition to 3D, the modelling of changes in features over time (i.e. 4D) is becoming increasingly important. This change may be discrete (e.g. ownership of a parcel) or continuous (e.g. movement of dunes). The integration of this fourth dimension into existing data structures represents a major research topic ranging from the translation of logical and conceptu-

al models described in the Unified Modelling Language (UML) to the implementation of the associated physical model in a DBMS. In the past, spatial data management was handled by GIS software outside the DBMS. As stated above, the next step will be the creation of a shared SDI for related organizations, the so-called information community. It will be a major challenge to integrate the temporal and scale aspects into a 5D model to replace their separate temporal and scale treatment.

The realization of the '5D deeply integrated model' and its implementation in a DBMS is a huge challenge. By first extending the traditional 2D models in different dimensions (third spatial dimension, temporal dimension, scale dimension) independently, important experience will be gained with the resulting different types of 3D models. Some of the resulting models are already operational, for example 3D space, though improved modelling may be required; for instance, support for true 3D topology is lacking. Next, the combination of two extended 3D models will be explored; for example, 3D space and time, or 3D space and scale, or 2D space and time and scale, resulting in different types of 4D models. These hardly explored models are expected to be feasible and to provide more insight into complex integrated modelling. Finally, using all these experiences the '5D model' is aiming at deeply integrating 3D space with both time and scale.

Core geo-DBMS: the geo-DBMS is becoming increasingly important in the transition to the SDI, because the entire geoinformation community depends on it. The research topics within this theme are topology structure management within the DBMS, the handling of 3D, temporal and dynamic objects within the DBMS, comparative functional and performance benchmarks, and XML (eXtensible Markup Language) support at the DBMS level. As the query aspect is dominant and the cost of memory chips falls, VLM (very large memory) DBMSs might offer a very suitable technical solution. They are powerful enough to serve large numbers of users via the Internet. Developments in hardware, software and database technology will contribute to the future shape of the geoinformation infrastructure. Current extensible DBMSs are very capable of storing 2D spatial data. However, more complex operations – such as on-the-fly generalization, enforcing correct topology during updates and 3D analysis – are not yet within the reach of these systems. New developments in DBMS technology, like extensible relational and object-oriented DBMSs and VLM databases, will underpin the new generation of DBMSs. At the same time, datasets are becoming bigger and bigger; this poses serious challenges in DBMS management, such as the handling of point clouds in AHN2 (actual height model of the Netherlands, version 2) or high-resolution imagery. Additional research themes all linked to geo-DBMS and part of the research programme are:

Computational geometry (spatial data structures/algorithms): linking GIS to computational geometry, spatio-temporal modelling and simulation models permit simpler, faster, more powerful and flexible use. The temporal component plays an important role in these models, leading to the development of dynamic geographic information systems.

Distributed geoinformation processing (network protocols, interoperability and web services): this theme studies topics in the field of distributed GISs (including grid and cloud computing), data transfer between various systems, interoperability, geoinformation standards, spatial models and query languages. Geoinformation processing will need to be subjected to geodetic quality control in the phases following data capture, such as data modelling, analysis and visualization. Such aspects as components and storage of quality, metadata and error propagation also have to be taken into account.

Mobile GIS (LBS): mobile GIS or location-based services involve the integration of at least three types of technologies: positioning (GPS, Galileo), wireless communication (GSM, GPRS, UMTS) and GIS (geo-DBMS, geocoding, routing, user interface, small-display cartography).

Due to the dynamic and mobile aspects, this type of environment brings obvious potential benefits to a number of applications (navigation/travel support, localized news services, traffic and fleet management, field observations and data collection, etc.), but it also has its own research challenges (in particular the architecture and design of these systems).

Knowledge engineering (ontology and semantics): agreeing on the syntax and formats of spatial data and the development of systems to be used for handling such data is the first step towards interoperability. But getting the syntax and format right does not mean that we understand one another's information – the essential next step is to reach agreement on the domain (or thematic) models to be used. It is important to study the semantic aspect of information in order to help human beings understand each other, and essential if we want machines to process this information in useful ways. To this end, the semantics will have to be formalized with the aid of semantic webs, ontologies, etc. OWL (Ontology Web Language) is a useful new tool in this field.

4.2.3 Domains

The domains are rooted in both sub-programmes.

Land Administration

This research aims to better support the real estate market, mortgaging, and land management in general. Innovative approaches, in both legal and spatial terms, are being developed ('juritecture'); for example 3D and 4D cadastres, and including links to valuation, taxation, registration of legal aspects of utilities, infrastructure, apartment units, water/groundwater rights, natural resources, etc. The research focuses on the security in legal relations between people and land, especially in the field of the multiple use of space, the transparency of the way these legal relations are implemented by land administration authorities, and the balance of public and private interests in this area. The key research topic Land Administration builds further on multidisciplinary research on land law and land administration performed in the past.

Supporting sustainable development: modern systems of land administration support not only the land market (including the national and international mortgage markets), but also land management in general and therefore sustainable development. Different approaches to land administration are applied in different jurisdictions. These national (or even regional) systems of land administration are increasingly being studied, compared and improved with the aid of more generalized conceptual models such as the Land Administration Domain Model (LADM). The LADM, approved as ISO 19152 (2012) by the International Organization for Standardization, offers a common standard for the land administration domain. It is an abstract, conceptual model with packages related to a) parties, b) basic administrative units, c) rights, responsibilities and restrictions, d) spatial units (parcels, and the legal space of buildings and utility networks), e) spatial sources (surveying), and f) spatial representations (geometry and topology). Based on the LADM, approaches that are innovative in both legal and geoinformation technology terms are being developed.

Supporting the European property market by transparency and security: support for and further development of the cross-border land market is receiving a lot of attention within Europe. An increase in cross-border real estate transactions within the European Union is creating a demand for easy, reliable access to information from the national land administrations of the Member States. Major developments have taken place in this field during recent years, such as Union Land Information Service (EULIS) or the CROBECO initiative by the European Land Registry Association (ELRA). The question is whether these initiatives really provide the

certainty and transparency the market requires. Against this background, we study the need for and possibility of a common system of land registration within the EU.

Multiple use of space asks for new form of land administration.

Supporting modern land use: urban areas have to cope with a dense population in a limited area. How to find the optimal way to deal with the increasing number of claims on that limited space by a multiplicity of users for different ways of land use (transport, industry, housing, recreation etc.)? A more efficient use of the available space, above and below ground, may be obtained by the legal division of this space in the third dimension (3D, multilevel constructions), or even in the fourth dimension (4D, e.g. time-share). The traditional systems of land administration, which are based on 2D cadastral parcels, are not suitable for organizing and modelling the information of such complex interests in land. We perform ongoing research on the different aspects of 3D and 4D cadastres with the aim of developing solutions that match the legal, organizational and technical cadastral requirements in a specific national setting.

Spatial Data Infrastructure

The SDI research studies techniques to maintain, disseminate and use large volumes of geoinformation within information infrastructures as well as the agreements that are necessary to successfully implement those techniques. SDIs make large amounts of geo-data accessible to a wide public, obviating the need to copy or re-collect data and at the same time guaranteeing the appropriate use of geo-data. SDI developments are currently on-going at various levels such as the basic registrations in the Netherlands, INSPIRE at the European level and the Land Administration Domain Model (LADM – ISO/TC211) at the global level.

The multiple and 'easy' use of geoinformation within SDIs requires specific technologies: interoperable information systems and services embedded in distributed service architectures and standard-based web applications. In addition, the production of large amounts of informal geo-referenced data generated by Web 2.0 facilities and by sensors in everyday devices (e.g. mobile telephones and satnavs) requires specific technologies. Several technology-oriented concepts (also see the Geoinformation Technology sub-programme) need further development to put acquired geo-data and geoinformation into practical and sensible use. These are: semantics, multi-scale issues, 3D modelling, 5D...nD modelling and use contexts of geoinformation.

From implicit to explicit semantics: a major breakthrough for the widespread reuse of geoinformation is the recently established domain models, such as those for water, cables and pipelines, spatial planning, etc. in the Netherlands and the INSPIRE data specifications accomplished at the European level. The next steps are applying semantic technologies to improve the formalism of the individual information models and to align similar concepts de-

fined in different domain models, so that linking to other domains becomes possible. At present the integration of geoinformation still requires human interpretation.

Multi-scale issues: automated generalization has received a lot of research attention ever since digital maps became available, and the first automated generalization workflows are becoming common practice. Currently spatial information is more often visualized on screens than on traditional maps, which brings other challenges (i.e. up-to-dateness might prevail over fulfilling all cartographic principles). Other issues include how to avoid inconsistencies and to use detailed information to update less detailed datasets in multi-scale environments, which is especially challenging when the data at different scales are captured by different organizations. Finally, research challenges can be found on the tGAP vario-scale data structure to solve remaining issues in the generalization of topographic data (i.e. 'maps').

3D modelling: the growing awareness of our intensively used environment requires 3D modelling of spatial situations and events. The national 3D standard established in 2012 stimulates 3D developments in practice. Remaining research challenges are: how to generate and maintain 3D information according to the new model, and how to disseminate 3D information within Web environments. The validation and reparation of 3D data (i.e. city models) also require further attention in order to use the information beyond visualization. Finally, the integration of 3D data from different domains (such as data from building information models and above/below surface information) requires further research.

User and policy contexts for SDIs: our SDI research has a focus on studying techniques for certain user and policy contexts. Therefore an important research question is how do research results that work in prototypes and small test areas work in practice and what further research is required? Another important research question for our use-oriented SDI research is how to convert location related policies and laws into implementations? Examples at the European and international levels are UN-GGIM, INSPIRE, EULF, Open data, Digital Agenda, GMES, etc. Examples at the national level are IMGeo/BGT, PDOK, key-registers, Omgevingswet, Open data, Digitale Steden Agenda.

Real-time Geoinformation

This key research topic focuses on developing concepts, frameworks, solutions and testing prototypes that permit knowledge-based use of geoinformation to assist the decision-making process in real-time situations, taking into account the spatial and temporal constraints, communication, network and visualization limitations. The requirements that SDI must fulfil are the most extreme in the case of real-time geoinformation use, such as in navigation, smart cities or emergency management. Technical and government aspects of SDI need to be made operational in real-time and for all types of data coming from heterogeneous sources (indoor/outdoor, above/below surface, design/measured data). The SDI for real-time applications should allow interaction with advanced wireless communication and positioning technologies, and ensure advanced context-aware spatial analyses, simulations and geovisualization. Important areas of SDI are of specific interest for real-time geoinformation: 5D modelling, localization and navigation, sensor web, and semantics.

5D modelling: a growing awareness of the benefits of 3D-5D data is observed in real-time geoinformation applications; e.g. in case of augmented reality. Further, increasing numbers of command and control systems have introduced 3D city models to be used as background information; time is a key attribute of any piece of information. There are still many topics that need further advancement: advanced 4D (3D+time) models have to be investigated to support urgent real-time operations and provide mechanisms for data archiving; 4D (3D+time) spatial operations are needed such as 3D overlay (plume spread, damage detection); 4D (3D+scale) indoor modelling; 3D models (geometry, semantics and topology, voxel

and vector) for seamless 3D (indoor/outdoor) navigation considering different locomotion models (walk, drive, fly); and crowd-sourced data collection and 5D modelling (3D+time+scale) of indoor and outdoor.

Localization and navigation: many approaches have been developed for positioning (GNSS, Wi-Fi, RFID, Bluetooth) and navigation (network-based, grid-based). The operational navigation systems are individual and a common operational picture is not provided. Many gaps are observed in indoor positioning and navigation as well. Several topics urgently require advancement: low-cost approaches for indoor positioning and localization; international standards for seamless indoor/outdoor localization and exchange of navigation information (e.g. IndoorGML); frameworks and algorithms for navigation of multiple actors, under dynamic circumstances (e.g. avoiding dynamic obstacles); user-adapted visualization (3D, 2D, text) and guidance (image, video, text, voice) appropriate to different situations (with less visibility, under stress).

Sensor web: real-time geoinformation applications are not based a one-way flow of information as used for data distribution (from server to clients). The geoweb can as well be used for real-time data collection; e.g. via VGI (Volunteered Geographical Information) using the many smart phones or cars with GPS, but also via the many sensors in our world. This so-called Sensor Web is based on specific sets of standards to realize the Smart-XXX (cities, dikes, roads, etc.) The research area includes the overall architecture, based on Internet protocols from ISO/TC211 and OGC from sensor web enablement (SWE family) and others such as WMS, WFS, GML, WCS, SLD, SVG, X3D, WebGL.

Semantics: real-time geoinformation applications involve different actors and dynamically integrating different data sets based on different background and vocabularies. Real-time geoinformation applications need to automate the search for and integration of information with respect to tasks, responsibilities, backgrounds and personal profiles of the different users. The topics of interests are building ontologies and linking them with data ontologies; investigating user profiles and developing approaches for knowledge-based data discovery and integration to filter the information with respect to the tasks of the users; approaches for automated semantic annotation of indoor environments for indoor localization and navigation.

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